FINAL

BIOLOGICAL SURVEY REPORT

FOR

CONSTRUCTION, OPERATION, AND MAINTENANCE OF VEHICLE FENCE AND RELATED TACTICAL INFRASTRUCTURE TUCSON SECTOR, ARIZONA

(b) (7)(E) STATION

U.S. DEPARTMENT OF HOMELAND SECURITY
U.S. CUSTOMS AND BORDER PROTECTION
U.S. BORDER PATROL TUCSON SECTOR, ARIZONA

Prepared by

Solutions Today for a Sustainable Tomorrow

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ABBREVIATIONS AND ACRONYMS

AZDA	Arizona Department of Agriculture
AZGFD	Arizona Game and Fish Department
BLM	Bureau of Land Management
BMP	Best Management Practices
BSR	Biological Survey Report
CBP	U.S. Customs and Border Protection
CFR	Code of Federal Regulations
cm	centimeter(s)
CWA	Clean Water Act of 1977
°F	Degrees Fahrenheit
e²M	engineering-environmental Management, Inc.
ESP	Environmental Stewardship Plan
FE	Federally Endangered
GAP	Gap Analysis Program
GIS	Geographic Information System
GPS	Global Positioning System
HDMS	Heritage Data Management System
HS	Highly Safeguarded
m	meter(s)
m^2	square meters
MBTA	Migratory Bird Treaty Act of 1918, as amended
MJD	Multi-Jurisdictional Dataset
mph	Miles per hour
NVCS	National Vegetation Classification System
OHM	Ordinary high water mark
ROE	Right-of-Entry
(b) (7)(E)	
USACE	U.S. Army Corps of Engineers
USBP	U.S. Border Patrol
U.S.C	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WRCC	Western Regional Climate Center

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1. INTRODUCTION

This Biological Survey Report (BSR) synthesizes information collected from a variety of literature sources and field surveys to describe the biological resources within the survey corridor; provides supporting information from the Project region; allows evaluation within the Project Environmental Stewardship Plan (ESP) of the potential effects of the Project on those biological resources; and provides the basis of recommendations for avoidance or reduction of those effects using mitigation including best management practices (BMPs). Information was gathered from publicly available literature, data provided by relevant land management agencies such as the U.S. Fish and Wildlife Service (USFWS) (b) (7)(E), review of aerial photography and U.S. Geological Survey (USGS) topographic maps, data from the State of Arizona, data from NatureServe, and field surveys of the survey corridor conducted in January and May 2008. Of particular importance were data from (b) (7)(E) whose entire southern boundary with Mexico comprises a portion of the survey corridor.

This BSR supports the Environmental Stewardship Plan by providing information on biological resources potentially affected by impacts resulting from the construction, operation, and maintenance of the tactical infrastructure. The BSR was prepared as an independent document that is an appendix to the Environmental Stewardship Plan developed for this Project. The survey corridor is approximately (b) (7)(E) in length, approximately 760.5 acres within (b) (7)(E) (b) (7)(E) area. In total, approximately 700.6 acres of mostly native vegetation providing wildlife habitat occurs in the survey corridor. The remaining area (59.9 acres) supports land use in the form of unvegetated desert wash bottoms, irrigated pasture, and roads and trails.

Herbaceous vegetation (i.e., desert grasslands, forblands, emergent wetlands) composes approximately 15.5 acres. Shrublands (i.e., dwarf, short, and tall) compose approximately 587.8 acres. Forests and woodlands comprise 97.3 acres of vegetation cover. The vegetation represents a combination of mostly native Chihuahuan Desert shrublands that have become established in sparse to dense stands on ridges, slopes, alluvial fans, outwash plains, and along desert washes, draws, creeks, and springs.

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2. PROJECT DESCRIPTION

U.S. Customs and Border Protection (CBP) proposes to construct, maintain, and operate tactical infrastructure (b) (7)(E) and associated access roads along the U.S./Mexico border in the U.S. Border Patrol (USBP), Tucson Sector, (b) (7)(E) Station, Arizona. The locations of tactical infrastructure are based on a USBP Tucson Sector assessment of local operational requirements (b) (7)(E). Tactical infrastructure will be constructed in Section FV-1b along the international border in (b) (7)(E) County, Arizona (see **Table 2-1**).

Table 2-1. Tactical Infrastructure Sections, Tucson Sector, (b) (7)(E) Station

General Location	Land Ownership	Type of Tactical Infrastructure	Length of New Fence Section/Length of Construction Access Roads
(b) (7)(E)	Private, Public, USWFS, BLM, Arizona State Lands	Primary vehicle fence, access roads	(b) (7)(E)
	Private, BLM	Primary vehicle fence, access roads	
		Total	

The vehicle barrier will be constructed in (b) (7)(E) sections (b) (7)(E) partially within the Roosevelt Reservation, land reserved in 1907 within 60 feet of the international boundary between the U.S. and Mexico along California, Arizona, and New Mexico. (b) (7)(E) Constructing the vehicle barrier will require improving or building (b) (7)(E) access roads, totaling (b) (7)(E) miles on USFWS, Bureau of Land Management (BLM), and private land parcels.

The final design will be prepared by a design/build contractor with oversight from the U.S. Army Corps of Engineers (USACE). Design criteria that have been established based on USBP operational needs require minimum standards for vehicle barriers, as follows: (1) capable of (b) (7)(E) (2) capable of (b) (7)(E); (3) designed to (b) (7)(E); (4) designed to (b) (7)(E) (b) (7)(E) (5) not impede the natural flow of surface water; and (6) to be as aesthetically pleasing as possible.

The area of impact for barrier construction is approximately (b) (7)(E) wide along the entire survey corridor, with wider but temporary impacts occurring at staging areas for construction materials and vehicles. Vegetation removal and land clearing/grading activities may occur on an as-needed basis.

2.1 Survey Methods

To provide flexibility in placement of tactical infrastructure within the survey corridor and to ensure consideration of potential impacts due to construction, patrol, and maintenance, surveys were conducted in an area extending (b) (7)(E) (b) (7)(E) on the north side (i.e., the side away from the international border) of the individual tactical infrastructure sections and extending at least (b) (7)(E) past the ends of the section (a total of 760.5 acres). Along access roads, the survey was conducted (b) (7)(E) corridor. The areas thus defined are referred to hereafter as the "survey corridor."

Field investigations of the survey corridor were conducted by biologists of engineering-environmental Management, Inc. (e²M): (b) (6) (senior ecologist), (b) (6) (staff biologist), (b) (6) (staff botanist), and (b) (6) (senior wetlands biologist). The January, April/May, and June 2008 surveys examined the survey corridor on January 14, from April 28 through May 2, and from June 9 through 13, 2008. A Contractor Site Visit Request Form was approved by the USACE, with assistance from the USFWS, (b) (7)(E) Manager, (b) (6), and USBP escorts. A second field visit was conducted on August 13, 2008 to assess a modification that exceeded the original survey corridor. The field investiagtiosn for this smaller area was conducted by senior e^2M biologists (b) (6) and (b) (6).

Due to the schedule requirements for acquiring field information, e²M assigned senior and staff ecologists/biologists familiar with the USBP Projects, reporting process, vegetation, wetlands/waters of the United States, wildlife habitat classification and mapping protocols, and field sampling methods to intuitively examine the landscape and survey corridor for the (b) (7)(E) length. Further, senior e²M natural resources staff used USFWS species lists and comprehensive conservation planning data (USFWS 1995) to ensure accurate identification of plant species and competent surveys for rare plants, wildlife, and potential habitat. The surveys were controlled, in that right-of-entry (ROE) was approved for the entire corridor and access road widths, and survey crews were in contact with USBP operations. While on (b) (7)(E), field biologists were accompanied by a USFWS law enforcement officer and were met by the Refuge Manager for sensitive site overviews. Investigations included preparing lists of observed plant and wildlife species; an assessment of habitat and surveys for rare plant and wildlife species; landscape photography points; observation points recording dominant species, location, cover, environmental conditions, and photodocumentation; determination of potential wetlands and other waters of the United States for future research; locations of major desert

washes; and general note taking of natural resources, cultural resources, and other Environmental Stewardship Plan reporting needs.

Biologists walked the entire survey corridor, including all the access road corridors and staging areas. The survey team conducted reconnaissance level surveys on areas of land use (irrigated pasture and sites devoid of vegetation including playas, desert wash bottoms, and access roads) and examined in detail areas containing unique species compositions or habitat that might be conducive to sensitive species (desert grasslands, shrublands, riparian woodlands and forests, emergent wetlands, etc.). Observation data (Universal Transverse Mercator [UTM] coordinates, photographs, field notes, environmental information, vegetation structure, and plant community composition) were recorded at regular intervals along the corridor where vegetation occurred as homogenous stands and also where plant communities presented substantial shifts in species composition. These data were used to generate a vegetation classification and map to facilitate delineation of habitat types, analyses of potential sensitive species occurrences, and analyses of potential Project impacts on biological resources. The botanist and wildlife biologist specifically examined habitats to determine the presence of state- and Federal-listed species (see **Table 2-2**). Descriptions of the federally listed species developed by NatureServe (2008) are provided in **Attachment A**.

Table 2-2. Federal Threatened and Endangered Species and Arizona Wildlife Species of Concern Occurring Within (b) (7)(E) County

Common Name	Scientific Name	Federal Status	State Status
FISH AND INVERTEBRATES			
Beautiful shiner	*Cyprinella Formosa*	**LT**	**WSC**
Desert pupfish	*Cyprinodon macularius*	**LE**	**---**
Gila chub	*Gila intermedia*	**LE**	**WSC**
Yaqui chub	*Gila purpurea*	**LE**	**WSC**
Yaqui catfish	*Ictalurus pricei*	**LT**	**WSC**
Spikedace	*Meda fulgida*	**LT**	**---**
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	**LE**	**---**
Yaqui topminnow	*Poeciliopsis occidentalis sonoriensis*	**LE**	**WSC**
Loach minnow	*Tiaroga cobitis*	**LT**	**---**
Huachuca springsnail	*Pyrgulopsis thompsonii*	**C**	**---**
AMPHIBIANS			
Sonora tiger salamander	*Ambystoma tigrinum stebbinsi*	**LE**	**---**

Common Name	Scientific Name	Federal Status	State Status
Ramsey Canyon leopard frog	*Lithobates subaquavocalis*	**CA**	**---**
Chiricahua leopard frog	*Rana chiricahuensis*	**LT**	**WSC**
REPTILES			
New Mexico ridge-nosed rattlesnake	*Crotalus willardi obscurus*	**LT**	**—**
BIRDS			
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	**C**	**WSC**
Southwestern willow flycatcher	*Empidonax traillii extimus*	**LE**	**WSC**
Northern aplomado falcon	*Falco femoralis septentrionalis*	**LT, XN**	**---**
American peregrine falcon	*Falco peregrinus anatum*	**SC**	**WSC**
California brown pelican	*Pelecanus occidentalis californicus*	**PDL**	**---**
Mexican spotted owl	*Strix occidentalis lucida*	**LT**	**WSC**
MAMMALS			
Ocelot	*Leopardus pardalis*	**LE**	**---**
Lesser long-nosed bat	*Leptonycteris curasoae*	**LE**	**WSC**
Jaguar	*Panthera onca*	**LE**	**WSC**
PLANTS			
Cochise pincushion cactus	*Coryphantha robbinsorum*	**LT**	**HS**
Lemmon fleabane	*Erigeron lemmonii*	**FC**	**HS**
Huachuca water umbel (Cienega false rush)	*Lilaeopsis schaffneriana* var. *recurva*	**LE**	**HS**
Madrean ladies'-tresses	*Spiranthes delitescens*	**LE**	**HS**

Source: AZFGD 2008b, USFWS 2008a

Notes: LE = Listed Endangered; LT = Listed Threatened; FC = Federal Candidate; C = Candidate; CA = Conservation Agreement; PDL = Proposed for Delisting; PR = Protected; SC = Species of Concern; XN: Experimental Population; WSC = Wildlife of Special Concern in Arizona; HS = Highly Safeguarded Protected Native Plants (no collection allowed)

2.2 Arizona Game and Fish Department; Arizona Natural Heritage Program, Heritage Data Management System

The Arizona Heritage Data Management System (HDMS) was established to collect, synthesize, and catalog information concerning the distribution and

occurrence of species and habitats in need of special attention (Arizona Game and Fish Department [AZGFD] 2008a, 2008b). It is part of a global network of 80 Natural Heritage Programs and Conservation Data Centers. The HDMS is Arizona's most comprehensive source of information related to rare, threatened, and endangered animals, plants, exemplary natural communities, and other significant features. The data are publicly available from which to make prudent decisions weighing future development, economic growth, and environmental integrity (AZGFD 2008a, 2008b). While these data are continually updated, there are gaps in coverage and species information due to lack of access to land for inventory, data from many sources, and a lack of staff and resources to collect and process data for all rare and significant resources. To request information from the HDMS online, access: http://www.azgfd.gov/w_c/edits/hdms_ natural_ heritage.shtml.

For the survey corridor, HDMS data were used to assist with the evaluation of environmental impacts of the vehicle barrier section under consideration. The interpretation and extrapolation of the data included consideration that: (1) data gaps possibly occur because of the availability of data extraction from public information sources, (2) species and geographic coverage focused on the most rare species and ecosystems, and (3) the potential lack of precise locality data in some secondary sources exists. Because of the large proportion of public land versus private land in Arizona, the HDMS includes a representative inventory of rare resources in the state. It is based on the best data available to the AZGFD in terms of rare species locations and distributions.

The (b) (7)(E) County list of rare species was acquired from HDMS and consolidated into **Table 2-2**. The county lists include wildlife species of special concern in Arizona and highly safeguarded plant species. In general, species that appear on county lists do not all share the same probability of occurrence within a county (e.g., some species are migrants or wintering residents and a few species might be historic or considered extirpated within a county).

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3. ENVIRONMENTAL SETTING

The survey corridor climate is semiarid within the Xeric Climatic Region as described in Robinson et al. (2006). This region is characterized by deep, northwest-trending, alluvium-filled basins separated by linear mountain ranges (basin and range lowlands). Relatively recent volcanic activity was evident with many slopes covered by gravel and cobble of volcanic origin. Land surface elevations range from approximately 3,720 feet above mean sea level to more than 5,000 feet above mean sea level in the immediate Project region. Precipitation typically increases and temperatures decrease with increasing altitude in the Xeric Climatic Region during all seasons of the year. Low rainfall and high temperatures are characteristic of the basin and range lowlands (e.g., summers are long and hot and winters are short, dry, and cold and can include brief periods when temperatures are below freezing) (Robinson et al. 2006, Bailey 1995). Many of the streams in the Xeric Climatic Region are intermittent or ephemeral (i.e., more than 250 days annually of no flow), but can have high flow in response to intense thunderstorms.

The general climatic summary records for (b) (7)(E), Arizona (Station (b) (7)(E), have been prepared from 1948 to 2007 data (Western Regional Climate Center [WRCC] 2008). Average minimum temperatures (b) (7)(E) range from a low of 29 degrees Fahrenheit (°F) in December and January to 65°F in July, and average high temperatures range from 63°F in December and January to 96°F in June (WRCC 2008). The lowest temperature recorded was 2°F on December 8, 1978, and the highest temperature recorded was 109°F on June 26, 1990. The average annual precipitation is 14.2 inches, over half of which falls in July, August, and September during the summer monsoon season. A long growing season is experienced for the Project region, averaging 240 frost-free days (WRCC 2008). The evaporation rate during the summer season is high, about twice the precipitation amount, and averages about 70 inches annually in (b) (7)(E)

Upland soils within the survey corridor are classified within the Bonita-Sontag Association and valley floor soils have been classified within the Karro Association (USFWS 1995). Karro Association soils are typically deep and well-drained and formed in old alluvium from mixed igneous and sedimentary rocks on alluvial fans and uplands; they include (1) Karro Loam, (2) Bonita Clay, (3) Bonita Cobbly Clay, and (4) Riggs. The Bonita-Sontag Association soils are typically shallow and well-drained and formed in mixed slope alluvium from sedimentary and igneous rocks; they include (1) Stronghold, (2) Mabray, (3) Lampshire-Ridgelite, and (4) Gadwell-Caralampi Complex.

The vegetation of the basin and range lowlands of (b) (7)(E) Arizona has generally been classified under the Dry Domain (Map Unit 300), Tropical/Subtropical Desert Division (Map Unit 320) of Bailey (1995). The survey corridor is more finely classified by Bailey (1995) as the Chihuahuan Desert Province (Map Unit 321). The Arizona Gap Project (Bennett et al. 2004)

provided discussion and described plant geography to vegetation series using topographic features, climate, vegetation types, and terrestrial vertebrates. This system placed the survey corridor generally in the Nearctic Upland; Warm Temperate Desertland; Chihuahuan Desertscrub classification. Vegetation series that were described and are applicable to the survey corridor included (1) Creosotebush-Tarbush Series; (2) Mesquite Series; (3) Whitethorn Series; (4) Mixed Scrub Series, and (5) Scrub Grassland Series (Bennett et al. 2004).

4. BIOLOGICAL RESOURCES

4.1 Vegetation Classification

The USGS (Bennett et al. 2004) recognizes nine Nearctic Upland and Nearctic Wetland vegetation mapping units in the (b) (7)(E) Arizona, vicinity using a combination of plant species dominance, wildlife use, topography, hydrology, and geology. The vegetation series that are associated with the survey corridor include (1) Warm Temperate Grassland, Scrub-Grassland (Semidesert), Tobosa Grass-Scrub Series; (2) Warm Temperate Scrub-Grassland (Semidesert), Sacaton-Scrub Series; (3) Warm Temperate Desertland, Chihuahuan Desertscrub, Creosotebush-Tarbush Series; (4) Warm Temperate Desertland, Chihuahuan Desertscrub, Whitethorn Series; (5) Warm Temperate Desertland, Chihuahuan Desertscrub, Mesquite Series; (6) Warm Temperate Desertland, Chihuahuan Desertscrub, Mixed Scrub Series; (7) Tropical-Subtropical Swamp Riparian and Oasis Forests, Sonoran Riparian and Oasis Forest, Cottonwood-Willow Series; (8) Tropical-Subtropical Swamp and Riparian Scrub, Sonoran Deciduous Swamp and Riparian Scrub, Mixed Scrub Series; and (9) Tropical-Subtropical Marshland, Sonoran Interior Marshland, Cattail Series. The entire corridor was predominantly characterized by Chihuahuan Desertscrub vegetation series.

NatureServe (2008) has defined ecological systems to represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes such as drought, fire, or flooding. Ecological systems represent classification units that are readily identifiable by conservation and resource managers in the field. The ensuing vegetation description for the survey corridor was prepared in the framework of ecological systems that include (1) North American Warm Desert Riparian Woodland and Shrubland (CES302.753), (2) Apacherian-Chihuahuan Mesquite Upland Scrub (CES302.733); (3) Chihuahuan Mixed Desert and Thorn Scrub (CES302.734), (4) Apacherian-Chihuahuan Mesquite Upland Scrub (CES302.733), (5) North American Warm Desert Riparian Mesquite Bosque (CES302.752), (6) North American Warm Desert Wash (CES302.755), (7) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735), (8) North American Warm Desert Cienega (CES302.747), and (9) North American Warm Desert Playa (CES302.751). **Table 4-1** provides a crosswalk between the biotic communities described by the USGS and the ecological systems of NatureServe (2008).

Classification of existing vegetation within the survey corridor was achieved by accessing the survey corridor, access roads, and staging areas as planned, sampling observation points, and relating them to the NatureServe Explorer classification database directly or as provisional types (NatureServe 2008). At the coarsest level, the nine above-named ecological systems were determined and local vegetation types described using the national system.

Table 4-1. Crosswalk Relationship of USGS GAP Map Units and USFWS Habitat Types with NVCS Ecological Systems and Vegetation Alliances

Ecological System (NatureServe 2008) Provisional Vegetation Alliance	Vegetation Structure and Series	Habitat Types
Madrean Pinyon-Juniper Woodland - One-seed Juniper Wooded Herbaceous	Madrean Evergreen Forest - Oak-Pine Series	Chihuahuan Desert Scrub
North American Warm Desert Riparian Woodland and Shrubland - Fremont Cottonwood – Goodding Willow Forest - Fremont Cottonwood / Honey Mesquite Forest - Arizona Sycamore – Fremont Cottonwood / Honey Mesquite Woodland	Sonoran Riparian and Oasis Forest - Cottonwood-Willow Series Mogollon Mixed Broadleaf - Mixed Broadleaf Series Sonoran Deciduous Swamp and Riparian Scrub - Mixed Scrub Series Sonoran Interior Marshland - Cattail Series	Riparian Forest/Woodland Riparian Scrub Mesquite Bosque Marshland
Apacherian-Chihuahuan Mesquite Upland Scrub - Ocotillo – Tarbush Shrubland - Mortonia – Mariola Shrubland - Whitethorn – Mariola Shrubland	Chihuahuan Desertscrub - Whitethorn Series Chihuahuan Desertscrub - Mixed Scrub Series	Chihuahuan Desert Scrub
Chihuahuan Mixed Desert and Thorn Scrub - Creosotebush – Mariola Shrubland - Mariola Dwarf-shrubland - Creosotebush – Honey Mesquite Shrubland - Creosotebush – Tarbush Shrubland - Tarbush Shrubland - Shrubby Coldenia – Engelmann Prickly-pear Dwarf-shrubland	Chihuahuan Desertscrub - Creosotebush-Tarbush Series Chihuahuan Desertscrub - Mixed Scrub Series	Chihuahuan Desert Scrub
Apacherian-Chihuahuan Mesquite Upland Scrub - Honey Mesquite – Whitethorn Bajada Shrubland - Honey Mesquite / Hook Threeawn Shrubland - Honey Mesquite – Tarbush Shrubland	Chihuahuan Desertscrub - Mesquite Series	Chihuahuan Desert Scrub

Ecological System (NatureServe 2008) Provisional Vegetation Alliance	Vegetation Structure and Series	Habitat Types
North American Warm Desert Riparian Mesquite Bosque - Honey Mesquite – Four-wing Saltbush Shrubland - Honey Mesquite / Alkali Sacaton Woodland and Shrubland - Honey Mesquite Sparse Understory Woodland and Shrubland - Honey Mesquite – Littleleaf Sumac Shrubland	Chihuahuan Desertscrub - Mesquite Series	Chihuahuan Desert Scrub Mesquite Bosque Riparian Scrub
North American Warm Desert Wash - Seepwillow – Burro Bush Shrubland - Alkali Sacaton Herbaceous Vegetation - Wild Barley / Honey Mesquite Shrub Herbaceous Vegetation	Scrub-Grassland - Sacaton-Scrub Sonoran Deciduous Swamp and Riparian Scrub - Mixed Scrub Series	Chihuahuan Desert Scrub Desert Grassland Riparian Scrub
Apacherian-Chihuahuan Semi-Desert Grassland and Steppe - Hook Threeawn Herbaceous Vegetation - Desert Marigold Herbaceous Vegetation	Scrub Grassland	Desert Grassland

Note: NVCS = National Vegetation Classification System.

A finer level of classification equaling or approximating the vegetation alliance level of the National Vegetation Classification System (NVCS) (NatureServe 2008) was used to prepare the plant community discussions under each ecological system. Vegetation stands and patches that are generally unclassified in the current system and sampled within the Project area typically consisted of nonnative species including Bermuda Grass Herbaceous Vegetation, Russian-thistle Herbaceous Vegetation, and Common Cocklebur Herbaceous Vegetation.

Habitats observed, sampled, and photographed within the survey corridor range from upland mixed desert scrub and thorn-scrub throughout the alignment to riparian woodland and forest stands (b) (7)(E). Much of the vegetation cover along the (b) (7)(E) fence section consists of native shrublands characterized by honey mesquite, creosotebush, tarbush, whitethorn, shrubby coldenia, mortonia, and ocotillo; vegetation cover occupies approximately 88 percent of the corridor. Development is limited to one irrigated pasture and existing roads and trails; these land uses occupy approximately 12 percent of the corridor.

A brief description of each plant community observed within the section (FV-1b) is provided herein; they are distinguished using the NatureServe Vegetation Alliance level of classification or an approximation. Each community is illustrated and supported by representative ground photographs and foliar cover information for dominant and characteristic plant species.

4.1.1 Madrean Pinyon-Juniper Woodland Ecological System (CES305.797)

One-seed Juniper / Whitethorn Wooded Shrubland

The uplands and associated small drainages within (b) (7)(E) occupied 25.1 acres of the survey corridor and supported 2 to 4 meter (m) tall one-seed juniper that ranged in cover from 3 to 5 percent (see **Figure 4-1**). The tall shrub layer provided low to moderate coverand includes whitethorn, catclaw acacia, littleleaf sumac, and honey mesquite. The short and dwarf-shrub layers contribute low cover, up to 5 percent cover and include mortonia, creosotebush, prickly-pear cactus, and agave. The herbaceous layer provides low to moderate cover, predominantly from the bunchgrasses tobosa, black grama, bush muhly, and three-awn.

Figure 4-1. Representative Photographs of One-seed Juniper Habitat

4.1.2 North American Warm Desert Riparian Woodland and Shrubland Ecological System (CES302.753)

Fremont Cottonwood – Goodding Willow Forest

(b) (7)(E) supports a forest stand (b) (7)(E) at the international border which occupied 0.9 acre of the survey corridor. The draw was ponded at the international border and upstream approximately 50 m had been hardened using gabions filled with rocks to reduce erosion (see **Figure 4-2**). (b) (7)(E) measured approximately 60 m from bank-to-bank and had become incised from 5 to 8 m deep; the banks are nearly vertical. Debris lines on the trees suggest flows that could exceed 1.5 m in depth. The draw has perennial springs and near-to-surface ground water which provides habitat for

riparian and wetland plant species. Fremont cottonwood trees up to 30 m tall have become established on the banks and first terrace of the draw and provide approximately 90 percent cover (see **Figure 4-2**). These trees were mature with large diameters-at-breast-height (60 to 70 centimeters [cm]). An understory layer of Goodding willow trees provided approximately 20 percent cover and attained heights of approximately 8 m tall. Honey mesquite trees provided low to moderate cover (10 to 15 percent cover) on the first terrace adjacent to the Fremont cottonwood stand. In the densest portion of this linear stand the understory was composed of leaf litter, but where canopy openings occurred the emergent wetland species southern cattail, three-square bulrush, and mixed graminoids provided moderate cover (up to 25 percent cover). Approximately (b) (7)(E) was a small stand of Fremont cottonwood trees with nearly 100 percent cover by three-square bulrush in the understory that was fed by a spring. (b) (7)(E) provided rare and valuable wildlife habitat with the tallest structural component of any plant community along this portion of the international border. Its waters also support three endangered fish species. The small Fremont cottonwood stand to the west provided active nest sites for the gray hawk, a pair of which was in residence.

Figure 4-2. Representative Photographs of Fremont Cottonwood – Goodding Willow Habitat

Apparently, (b) (7)(E) did not exist in the 1850s, but by the 1890s it occurred as a creek lined with cottonwood trees (Lanning 1981 in USFWS 1994). Later, it became a ditch approximately 3 to 5 m deep, 5 to 25 m in width, and was typically dry.

Fremont Cottonwood / Honey Mesquite Forest

(b) (7)(E) supports a forest stand (b) (7)(E) at the international border that occupied 3.6 acres within the survey corridor. The wash has a sandy bottom, is approximately 40 m wide, has incised up to 4 m deep within nearly vertical banks, and has sufficient surface flows and near-to-surface groundwater to support riparian plant species (see **Figure 4-3**). Debris lines captured on the trees suggest flows that could exceed 1 m in depth. Fremont cottonwood trees up to 25 m tall have become established in the wash bottom and on banks and provide approximately 70 percent canopy cover. These trees are approximately 15 years of age and have diameters-at-breast-height of approximately 35 to 40 cm. Higher on the banks and on the first wash terrace, honey mesquite trees to 15 m tall provide moderate cover, up to 20 percent cover. Giant dropseed and alkali sacaton contributed low cover on the wash banks and first terrace. This is a rare and valuable wildlife habitat, with the tallest structural component of any plant community along this portion of the international border.

Arizona Sycamore - Fremont Cottonwood / Honey Mesquite Woodland

The wash located in (b) (7)(E) at the international border provides habitat for a sparse woodland community on the banks and terraces, occupying 14.8 acres within the survey corridor. The wash has incised approximately 4 m deep, contained a barren sandy or gravelly channel. Cobble was deposited on point bars and terraces; it ranged from 10 to 20 m wide (see **Figure 4-4**). Arizona sycamore and Fremont cottonwood trees up to 15 m tall have become established on the banks and first terraces of the moderately large desert wash and provide low to moderate cover, approximately 10 to 20 percent and 1 to 5 percent, respectively. The short-statured honey mesquite trees occurred as understory to the taller trees or formed monotypic stands or clumps on the desert wash banks and terraces; they provided low to moderate cover from 10 to 20 percent cover. Additional understory trees included hackberry, green ash, one-seed juniper, and oak which provided low cover. The tall shrub layer ranged from 2 to 5 m tall and was characterized by honey mesquite which provided moderate cover, from 10 to 30 percent cover. The short shrub layer provided sparse cover and was characterized by littleleaf sumac, wait-a-minute, wolfberry, and burro bush. The herbaceous layer was comprised of grasses providing low to moderate cover, from 10 to 25 percent cover and included sideoats grama, deer grass, sand dropseed, tobosa, and big dropseed.

Figure 4-3. Representative Photographs of Fremont Cottonwood / Honey Mesquite Habitat

Figure 4-4. Representative Photographs of Arizona Sycamore - Fremont Cottonwood / Honey Mesquite Habitat

4.1.3 Apacherian-Chihuahuan Mesquite Upland Scrub Ecological System (CES302.733)

Ocotillo – Tarbush Shrubland

(b) (7)(E) supported tall shrub stands on rocky outcrops, cobbly and gravelly colluvial deposits, and outwash fans on 32.8 acres of the survey corridor (see **Figure 4-5**). The tall shrub layer was 3 to 5 m high and characterized by ocotillo that provided low to moderate cover (5 to 25 percent cover), typically with a short shrub understory of tarbush that provided low cover (5 to 15 percent cover). Associated short and dwarf-shrubs provided sparse cover and included mariola, yucca, little-head snakeweed, rainbow cactus, and wait-a-minute. South-facing rock outcrops within this type supported dense patches of little bluestem and sparse cover of tobosa and threeawn.

Mortonia - Mariola Shrubland

Limestone outcrops and colluvial slopes in the vicinity of (b) (7)(E) and small drainage systems in (b) (7)(E) supported unique short shrub stands on 26.6 acres within the survey corridor (see **Figure 4-6**). The short shrub layer was characterized by mortonia that provided low to moderate cover (5 to 15 percent cover) in association with the dwarf-shrub mariola that contributed low to moderate cover (5 to 20 percent cover). The tall shrub layer was often present, provided sparse to low cover, and included ocotillo, whitethorn, squawbush, and one-seed juniper. The remaining short and dwarf-shrub layers were diverse, contributed sparse to moderate cover, and included creosotebush, tarbush, althorn, agave, yucca, sotol, Engelmann prickly-pear, and shrubby coldenia. The herbaceous layer contributed sparse cover and included hook threeawn, tobosa, and fluffgrass.

Figure 4-5. Representative Photographs of Ocotillo – Tarbush Habitat

Whitethorn - Mariola Shrubland

(b) (7)(E) supported short and dwarf-shrub stands on the driest exposures and steepest ridges (see **Figure 4-7**). The dwarf-shrub layer was characterized by mariola which provided low cover, up to 10 percent cover, and the tall shrub layer was characterized by low cover of whitethorn (5 percent cover). Associated tall and short shrubs that contributed sparse to low cover included ocotillo, yucca, and Palmer agave. The herbaceous layer provided sparse cover and was characterized by tobosa and fluffgrass. This type occurred on the edge of the survey corridor and occupied 0.7 acre.


Figure 4.6. Representative Photographs of Limestone Ridge and Slope Habitat


Figure 4-7. Representative Photographs of Steep Ridge and Slope Habitat

4.1.4 Chihuahuan Mixed Desert and Thorn Scrub (CES302.734)

Creosotebush – Mariola Shrubland

Gentle slopes and alluvial outwash plains, typically gravelly and sandy in texture, supported consistent dominance by short and dwarf shrubs of this type which occupied 234.7 acres of the survey corridor (see **Figure 4-8**). The short shrub creosotebush and dwarf-shrub mariola characterized this type and each provided from 5 to 25 percent cover within stands. The tall shrub layer contributed sparse to low cover (1 to 10 percent cover) and included ocotillo, whitethorn, and honey mesquite. The remaining short and dwarf-shrub layers contributed sparse to low cover (1 to 10 percent cover) and included tarbush, yucca, Engelmann prickly-pear, cane cholla, and shrubby coldenia. The herbaceous layer was low in terms of species diversity, contributed sparse cover or was absent, and was characterized by fluffgrass, tobosa, and sprangletop.

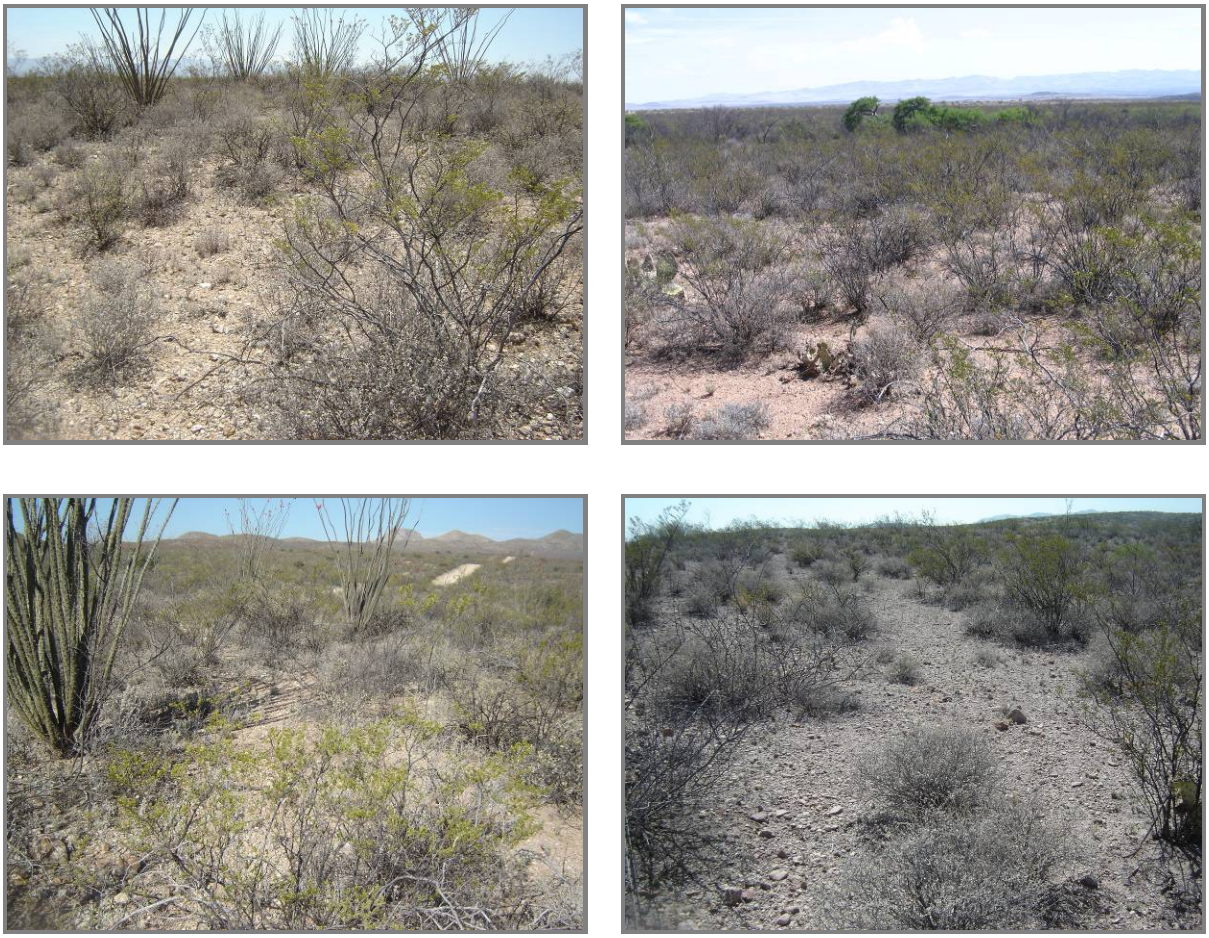

Figure 4-8. Representative Photographs of Creosotebush - Mariola Desert Slopes and Plains Habitat

Mariola Dwarf-shrubland

This type is unique and had become established on a south-facing slope armored by volcanic rocks, occupying 2.4 acres within the survey corridor (see **Figure 4-9**). The dwarf-shrub mariola characterized the site, providing 20 percent cover. Associated tall and short shrubs provided sparse cover and included creosotebush and honey mesquite. Herbaceous vegetation was nearly absent; the short bunchgrass tobosa contributed sparse cover.


Figure 4-9. Representative Photographs of Mariola - Volcanic Slope Habitat

Creosotebush – Honey Mesquite / Tobosa Shrubland

Gentle to steep slopes, volcanic cobble exposures, and dissected plains supported mixtures of tall and short shrubs that were relatively consistent on 73.0 acres throughout the survey corridor (see **Figure 4-10**). This type is characterized by creosotebush and honey mesquite tall shrubs that each range in cover from 5 to 15 percent. Associated tall shrubs provided sparse cover and included littleleaf sumac, tarbush, four-wing saltbush, whitethorn, and shrubby coldenia. The herbaceous layer was patchy in distribution, contributed sparse to low cover (2 to 12 percent cover), and included tobosa and black grama.

Creosotebush – Tarbush Shrubland

Broad, gravelly plains supported moderate stands of this type (b) (7)(E) (b) (7)(E) where 48.1 acres of the survey corridor supported this type (see **Figure 4-11**). Creosotebush short shrubs provided low cover, up to 15 percent, and tarbush short shrubs provided sparse cover (up to 4 percent cover) in these open stands. In one stand, the tall shrub ocotillo contributed sparse cover. Associated short and dwarf-shrubs contributed sparse cover and included whitethorn, mariola, soaptree yucca, and shrubby coldenia. The grasses bush muhly and tobosa provided sparse cover in one stand.

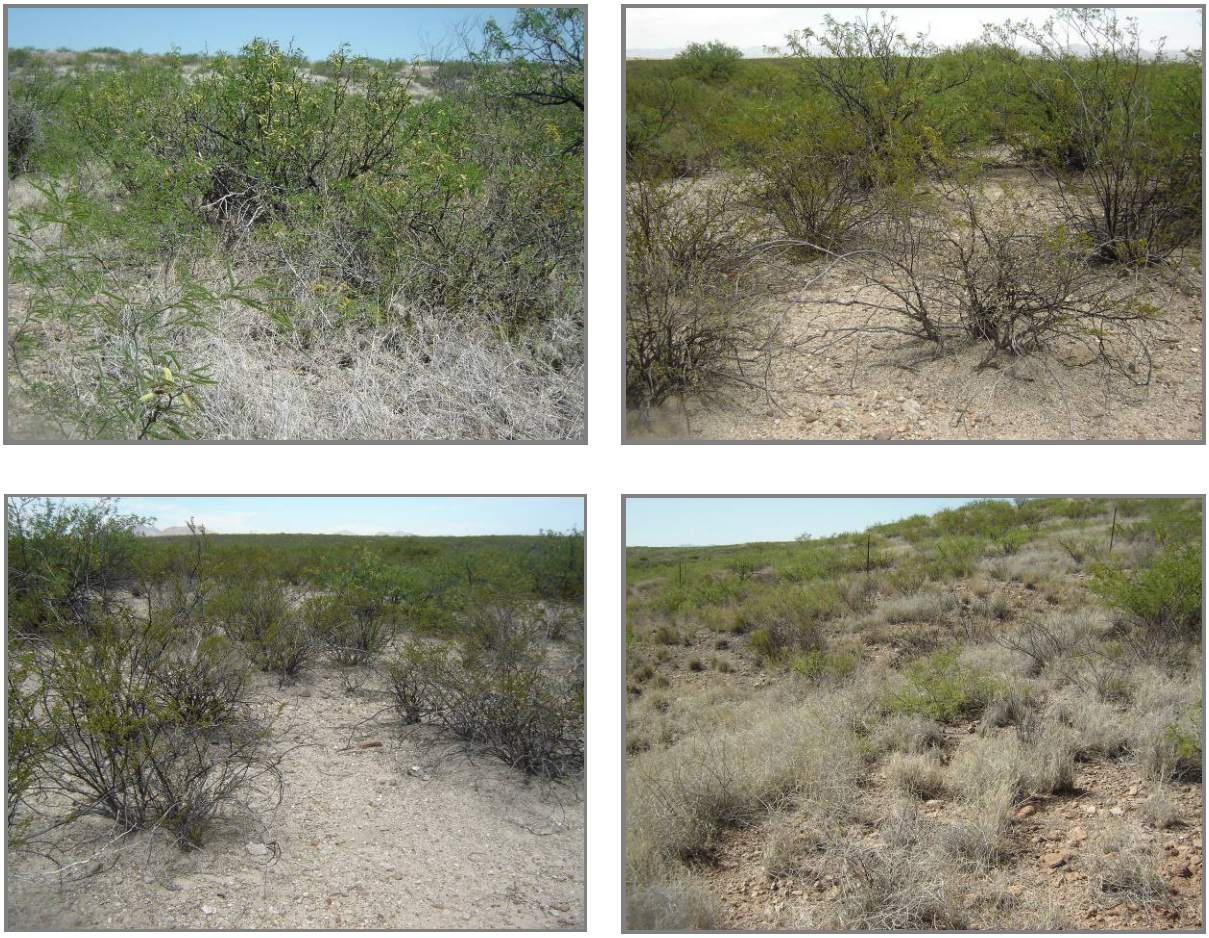

Figure 4-10. Representative Photographs of Creosotebush – Honey Mesquite Slope and Dissected Plain Habitat

Tarbush Shrubland

An individual sandy and gravelly alluvial fan was characterized by moderate cover (35 percent cover) of tarbush that occupied 1.1 acres of the survey corridor (see **Figure 4-12**). The remaining short and dwarf-shrub layers contributed sparse to low cover (up to 10 percent cover) and included whitethorn, honey mesquite, yucca, prickly-pear, and small-headed snakeweed. The herbaceous layer was absent from this stand.

Shrubby Coldenia – Engelmann Prickly-pear Dwarf-shrubland

This type became established on a dry ridge off a hill with gravelly, thin soils and occupied 1.6 acres in the survey corridor (see **Figure 4-13**). The dwarf-shrubs shrubby coldenia (12 percent cover) and Engelmann prickly-pear (8 percent cover) characterized the site and provided low to moderate cover. Sparse cover was provided by the short shrub creosotebush. The herbaceous layer contributed sparse cover and was characterized by fluffgrass.

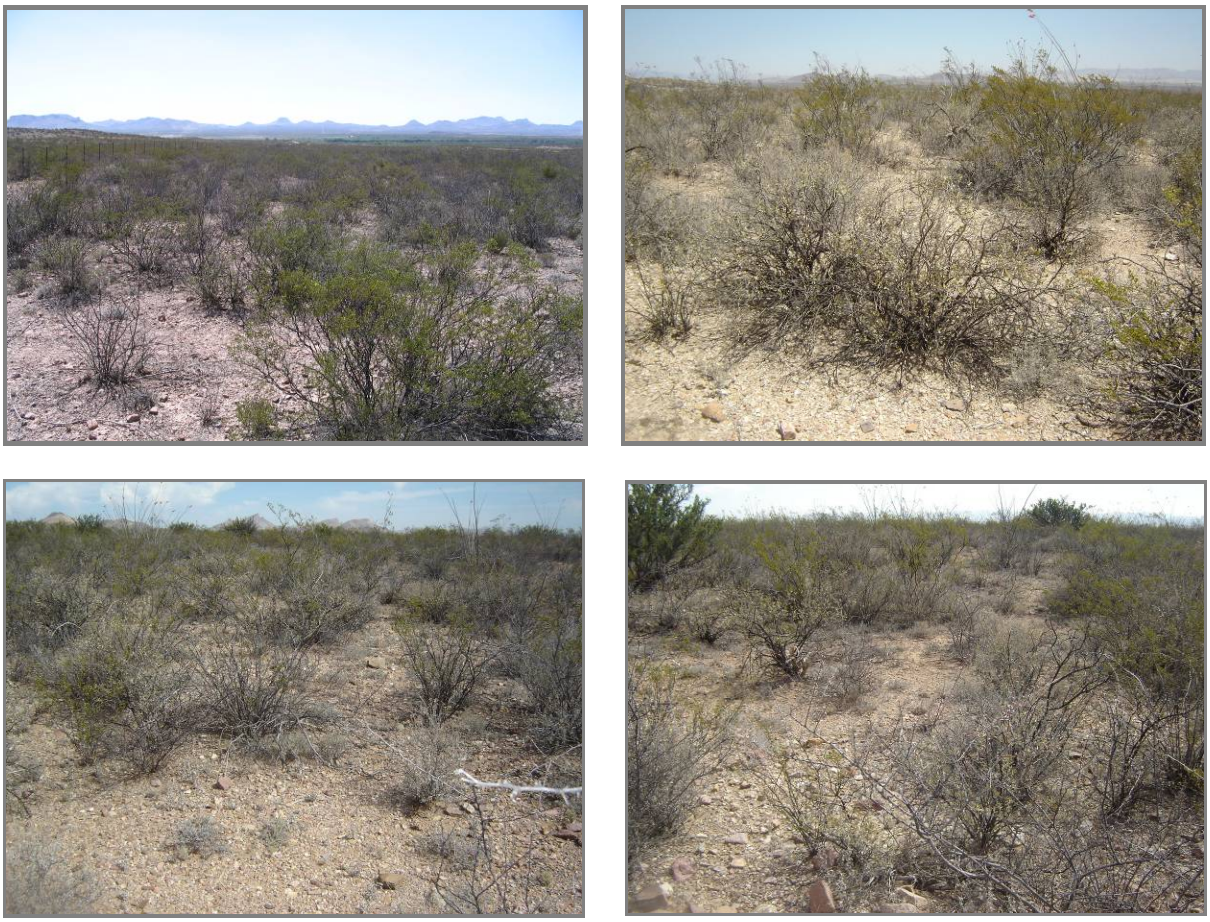

Figure 4-11. Representative Photographs of Creosotebush – Tarbush Desert Plain Habitat

4.1.5 Apacherian-Chihuahuan Mesquite Upland Scrub Ecological System (CES302.733)

Honey Mesquite – Whitethorn Bajada Shrubland

Several small, gravel and cobble-covered hilltops and ridges occur (b) (7)(E) (b) (7)(E) and continue to (b) (7)(E) occupying 10.8 acres within the survey corridor (see **Figure 4-14**). These exposed sites support low cover, between 15 to 20 percent cover of short and dwarf-shrubs including honey mesquite, whitethorn acacia, four-wing saltbush, creosotebush, Mormon-tea or jointfir, and little-head snakeweed. No one shrub contributed more than 5 percent cover in these stands.

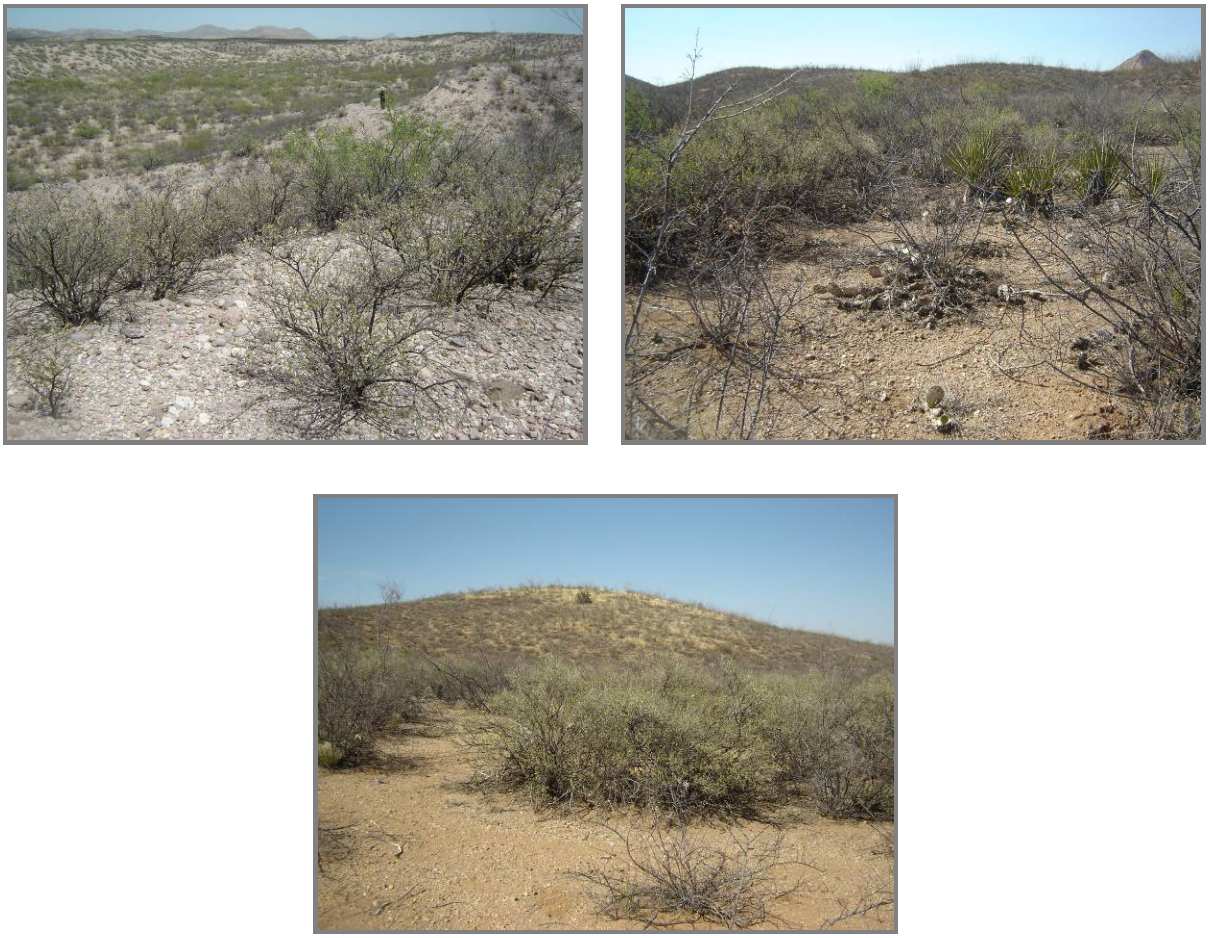

Figure 4-12. Representative Photographs ofTarbush Alluvial Fan Habitat

Honey Mesquite / Hook Threeawn Shrubland

A single stand of this vegetation type occurred on a cobbly ridge and occupied 7.7 acres of the survey corridor (see **Figure 4-15**). The tall shrub layer was characterized by 2 to 4 m high honey mesquite that provided moderate cover, up to 30 percent cover, and the short bunchgrass hook threeawn also provided moderate cover (up to 40 percent cover). The short shrub layer contributed low cover (less than 10 percent cover) and included whitethorn, yucca, and Engelmann prickly-pear. Tobosa provided low cover (5 percent cover) in the herbaceous layer.

Figure 4-13. Representative Photographs of Dwarf Shrub Dry Ridge Habitat

Honey Mesquite - Tarbush Shrubland

This vegetation type occurred on a cobbly volcanic slope and on sandy soils within a braided desert wash (b) (7)(E), occupying 5.5 acres in the survey corridor (see **Figure 4-16**). The tall shrub (to 4 m high) honey mesquite provided moderate cover (20 to 35 percent cover) and the short shrub tarbush provided low cover (4 percent cover). Whitethorn provided sparse cover in the tall shrub layer of one stand, and the short and dwarf-shrubs creosotebush, four-wing saltbush, Engelmann prickly-pear, and small-headed snakeweed contributed sparse to low cover. The herbaceous layer provided sparse cover by fluffgrass and alkali sacaton.

Figure 4-14. Representative Photographs of Honey Mesquite – Whitethorn Bajada Habitat

Figure 4-15. Representative Photographs of Honey Mesquite / Hook Threeawn Ridge Habitat

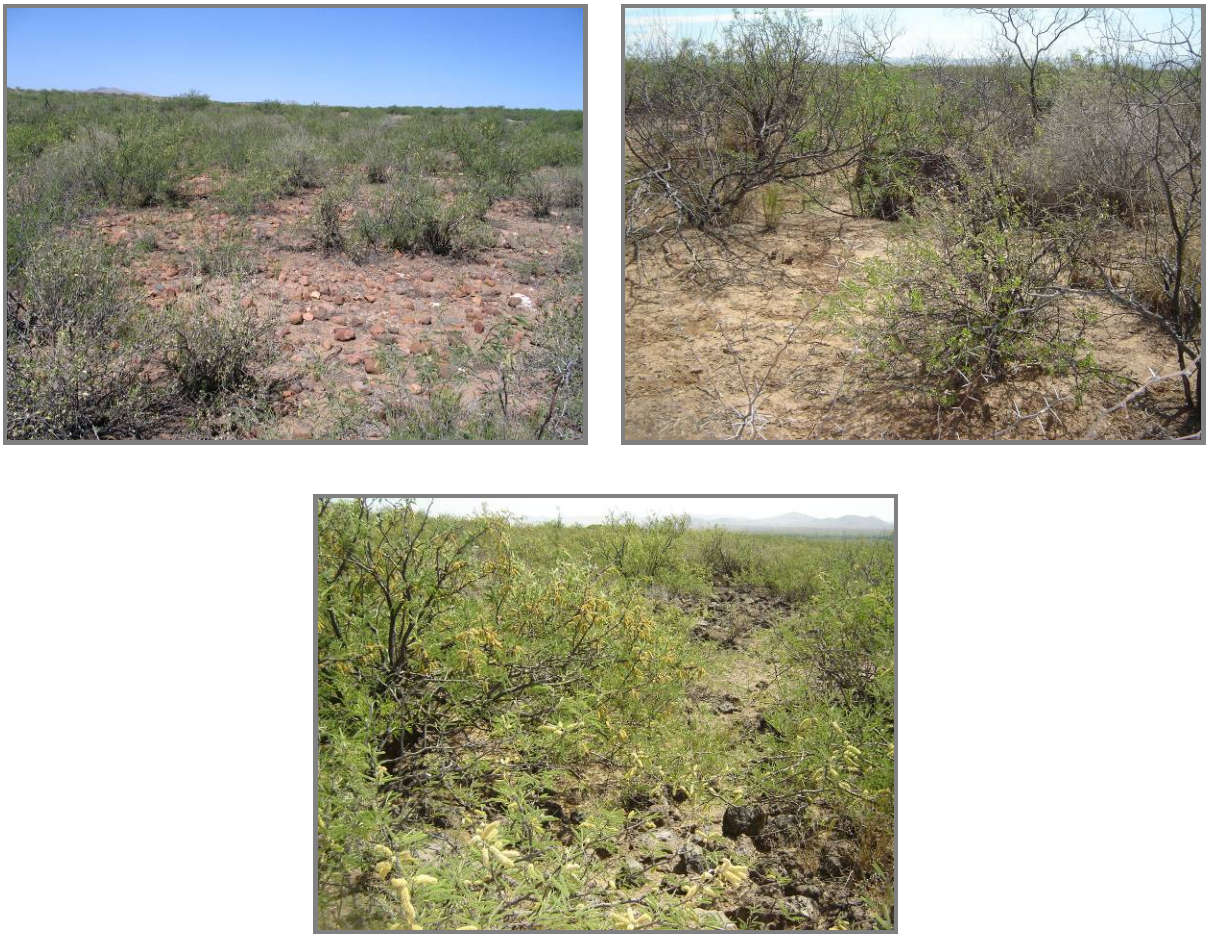

Figure 4-16. Representative Photographs of Honey Mesquite – Tarbush Slope and Braided Wash Habitat

4.1.6 North American Warm Desert Riparian Mesquite Bosque Ecological System (CES302.752)

Honey Mesquite – Four-wing Saltbush Shrubland

The relatively flat alkaline soils (b) (7)(E) and the volcanic cobble slopes (b) (7)(E) supported this type on 25.8 acres of the survey corridor (see **Figure 4-17**). Honey mesquite tall shrubs to 4 m high provided low to high cover (15 to 60 percent cover) and four-wing saltbush short shrubs provided 5 to 12 percent cover in the understory. In one stand, creosotebush and soaptree yucca provided sparse cover in the short shrub layer and small-headed snakeweed provided sparse cover in the dwarf-shrub layer. The herbaceous layer was characterized by sparse cover of tobosa and alkali sacaton. Within the refuge a strip of land adjacent to the border appeared to have been bladed or similarly treated to remove honey mesquite shrubland habitat. The treated area occupied 4.1 acres within the survey corridor and had recovered to sparse cover of honey mesquite, four-wing saltbush, and tobosa that in total provided less than 10 percent cover (see **Figure 4-17**).

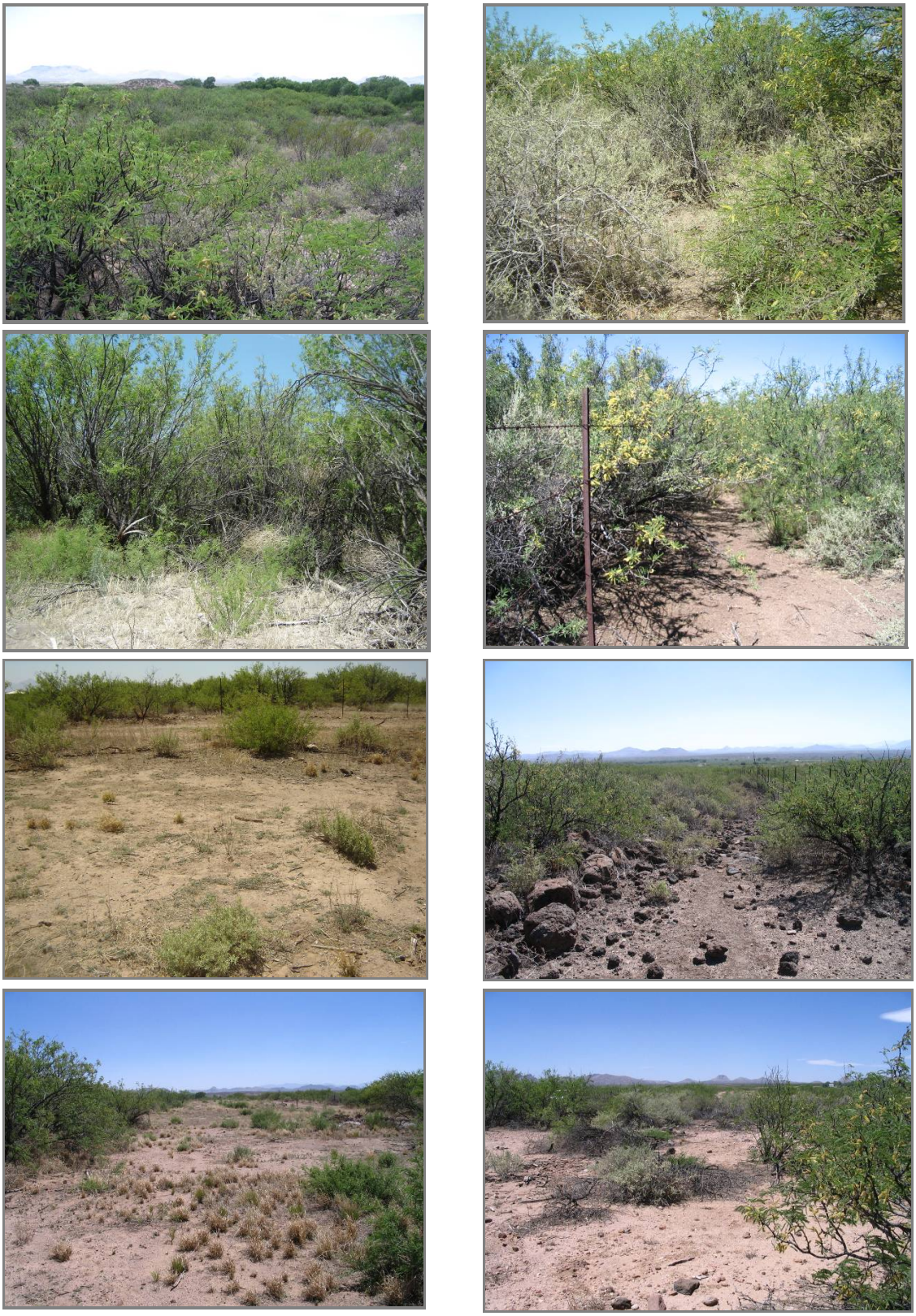

Figure 4-17. Representative Photographs of Honey Mesquite – Four-wing Saltbush Alkaline Flat, Volcanic Slope, and Bladed Habitat

Honey Mesquite – Alkali Sacaton Woodland and Shrubland

This type occurs in drainage bottoms that include upper (b) (7)(E), large desert washes, and broad swales of the eastern Project terminus and occupies (b) (7)(E) within the survey corridor (see **Figure 4-18**). Honey mesquite trees or tall shrubs to 5 m tall occurred on the wash and swale banks or elevated sediment bars and provided low to moderate cover (15 to 40 percent cover). The tall bunchgrass alkali sacaton provided low to moderate cover (5 to 25 percent cover) on the wash and swale bottoms. In the remaining shrub layer, sparse cover was contributed by netleaf hackberry, four-wing saltbush, desert broom, yerba de pasmo, burro bush, littleleaf sumac, tarbush, and little-head snakeweed. In the remaining herbaceous layer, sparse cover was contributed by scratchgrass and Dakota verbena. This type was similar to the Honey Mesquite / Four-wing Saltbush Shrubland; however, the cover by four-wing saltbush short shrubs was sparse, typically 1 percent or less in terms of foliar cover.

Figure 4-18. Representative Photographs of Honey Mesquite – Alkali Sacaton Creek and Wash Habitat

Honey Mesquite Sparse Understory Woodland and Shrubland

Stands of honey mesquite with little understory vegetation have become established on the terraces of (b) (7)(E), and a relatively flat plain where they form moderately dense woodlands and tall shrublands (see **Figure 4-19**). Honey mesquite trees and tall shrubs range from 3 to 10 m in height, provided 40 to 85 percent cover, and occupied 20.7 acres of the survey corridor. The short shrub layer provides sparse cover and may include four-wing saltbush, creosotebush, and burro bush. The herbaceous layer provides sparse cover and includes tobosa, giant dropseed, six weeks fescue, Russian-thistle, and London rocket. One stand occurred near a windmill and exhibited signs of cattle foraging and resting under the tree canopies, likely on an annual basis.

Figure 4-19. Representative Photographs of Honey Mesquite with Little Understory Cover Habitat

Honey Mesquite – Littleleaf Sumac Shrubland

Small desert washes, approximately 5 to 15 m wide, totaled 7.3 acres in the survey corridor and will be crossed by access roads (see **Figure 4-20**). The washes were coequally characterized by 2 to 5 m tall honey mesquite and littleleaf sumac tall shrubs that together provided 30 percent cover. Short shrubs occupied the understory and small openings on wash banks and were characterized by low cover of tarbush (10 percent cover) and four-wing saltbush (4 percent cover). The herbaceous layer contributed sparse cover and included giant dropseed and annual desert holly.

Figure 4-20. Representative Photograph of Honey Mesquite – Littleleaf Sumac Desert Wash Habitat

4.1.7 North American Warm Desert Wash Ecological System (CES302.755)

Seepwillow – Burro Bush Shrubland

This type occurs just outside the survey corridor on a meander terrace (b) (7)(E) (b) (7)(E) and occasionally to rarely experiences overbank flooding following precipitation events. (b) (7)(E) is very broad at this location, up to 100 m wide from bank to bank, has a sandy to gravelly channel that is mostly devoid of vegetation, and is incised up to 10 m deep (see **Figure 4-21**). The tall shrub yerba de pasmo (seepwillow) provides low cover (up to 10 percent cover) along with a few individual desert willow tall shrubs, which occupy a slightly elevated second terrace. The first terrace lay slightly above the channel and supported the short shrub burro bush which provided low cover up to 15 percent cover. Alkali sacaton, the medium-tall bunchgrass, provided sparse cover in the herbaceous layer.

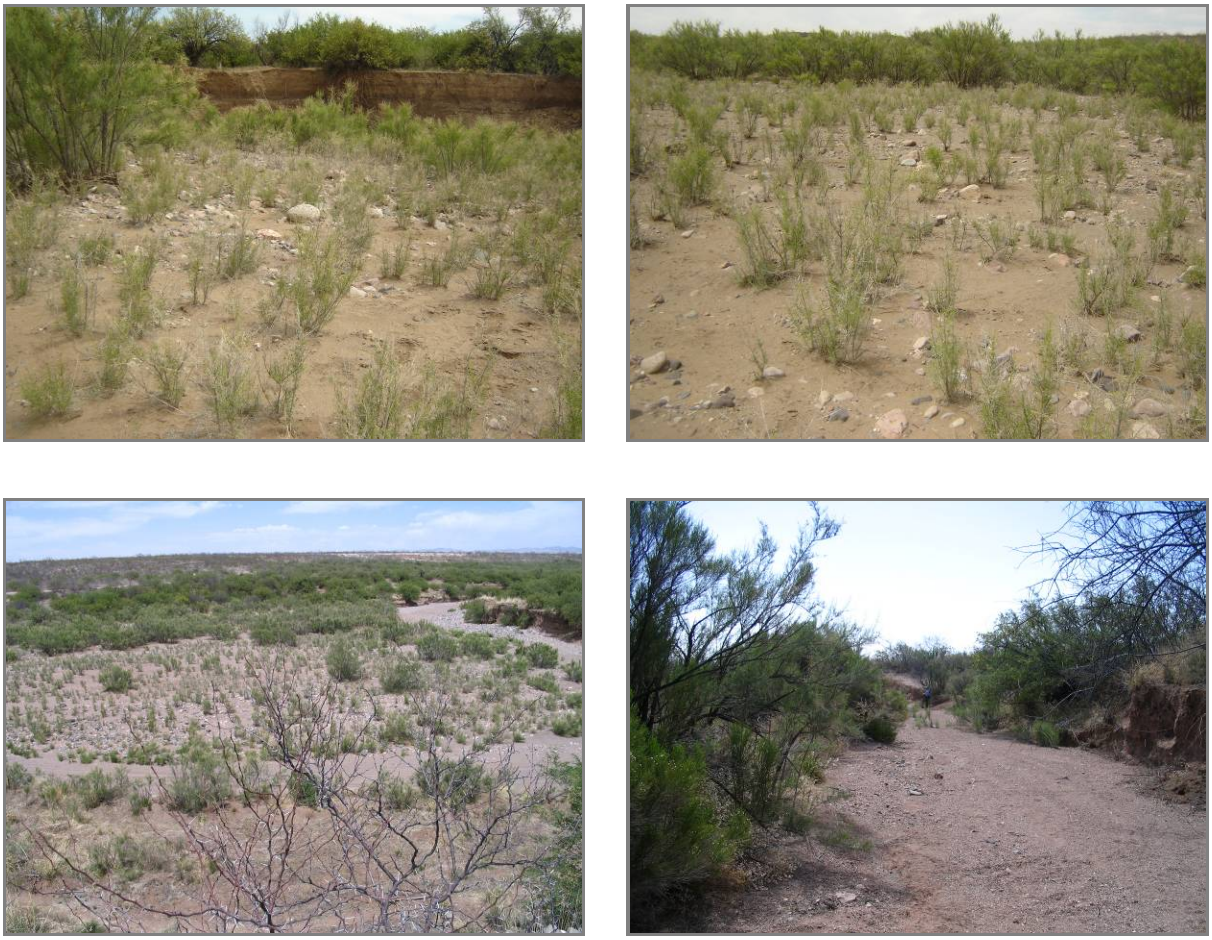

Figure 4-21. Representative Photographs of Seepwillow – Burro Bush (b) (7)(E) (b) (7)(E) Habitat

Alkali Sacaton Herbaceous Vegetation

A few larger desert washes and large swales (from 40 to 75 m wide) were characterized by 45 to 65 percent cover of alkali sacaton, a coarse bunchgrass that may be 1.5 m tall (see **Figure 4-22**). Additional grass and forb species occurred in sparse cover and included vine mesquite, Dakota verbena, and crimson sage. The tall and short shrub layer provided low to moderate cover (up to 15 percent cover) and included honey mesquite, littleleaf sumac, creosotebush, and four-wing saltbush. The shrub layer ranged from 1 to 4 m tall and contributed valuable wildlife habitat structure in the 6.9 acres examined in the survey corridor.

Figure 4-22. Representative Photographs of Alkali Sacaton Desert Wash Habitat

Wild Barley / Honey Mesquite Shrub Herbaceous Vegetation

A narrow drainage, up to 5 m wide, occurs (b) (7)(E) and carries flows across the international border into Mexico (see **Figure 4-23**). The drainage, which occupies 0.3 acre within the survey corridor, is cobble-lined, appears to be spring-fed, and has a high groundwater table. The drainage was characterized by low cover of the annual wild barley, which provided up to 15 percent cover in addition to sparse cover provided by the grasses foxtail barley, rescue grass, and rabbitfoot grass. The forbs common sunflower and yellow sweetclover provided sparse cover. Along the drainage banks, honey mesquite shrubs to 4 m tall and netleaf hackberry trees to 7 m tall contributed low cover (up to 10 percent cover) and provided structural value as wildlife habitat.

Figure 4-23. Representative Photographs of Wild Barley/ Honey Mesquite Small Drainage Habitat

4.1.8 Apacherian-Chihuahuan Semi-Desert Grassland and Steppe Ecological System (CES302.735)

Hook Threeawn Herbaceous Vegetation

A moderately large stand of hook threeawn, providing approximately 15 percent cover, has become established on clay soils deposited in the vicinity of a livestock corral (see **Figure 4-24**). Sparse shrub cover (up to 2 percent cover) of creostebush also occurs in this otherwise monotypic stand which occupies 1.8 acres within the survey corridor.

Figure 4-24. Representative Photographs of Hook Threeawn Flats Habitat

Desert Marigold Herbaceous Vegetation

An area that had been graded and cleared of creosotebush and mariola shrubs currently supported short-stature desert marigold forbs that provided low cover, (up to 8 percent cover) (see **Figure 4-25**). The disturbance covered 0.9 acre of the survey corridor and was maintained by ground squirrel and kangaroo rat burrowing and foraging activity, which was extensive across the site. The low-growing fluffgrass provided sparse grass cover, as did the dwarf-shrub little-head snakeweed.


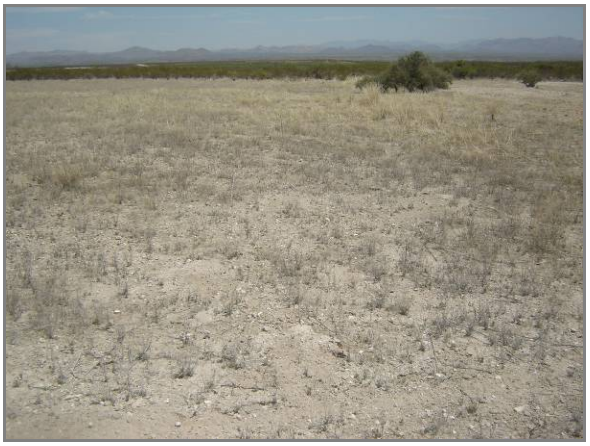

Figure 4-25. Representative Photographs of Desert Marigold Flats Habitat

4.1.9 North American Warm Desert Cienega Ecological System (CES302.747)

Slimleaf Bursage – Common Sunflower Herbaceous Vegetation

A large old field, formerly an extensive cienega drained historically to support farming, occurs adjacent to (b) (7)(E) (see **Figure 4-26**). It holds water following large precipitation events and the old field/former cienega bottom is well-vegetated with forbs and grasses. The forbs slimleaf bursage, common sunflower, and prostrate saltbush provide moderate cover (up to 30 percent cover) within the 2.2 acres of the stand within the survey corridor. Common sunflower stalks from the previous year's growth attained heights to 3 m tall. Grasses provide low to moderate cover and include inland saltgrass, giant dropseed, and the nonnative Bermuda grass. The dwarf-shrub seep weed provides sparse cover. A (b) (7)(E) is illustrated in **Figure 4-26**.

According to the USFWS (2008), the (b) (7)(E) once supported permanently flowing creeks, springs, and marshy wetlands composing this cienega. Giant sacaton grasslands occupied portions of the valley and were described as a luxuriant meadow some 8 or 10 miles wide. The dependable water sources and herbaceous vegetation cover made the area invaluable to fish and wildlife and to humans.

Figure 4-26. Representative Photographs of Slimleaf Bursage – Common Sunflower Cienega Habitat (b) (7)(E)

4.1.10 North American Warm Desert Playa Ecological System (CES302.751)

Russian-thistle Semi-natural Herbaceous Vegetation

A depression or playa that was nearly devoid of vegetation occurred (b) (7)(E) (b) (7)(E) and formed across the border into Mexico. This depression apparently fills and ponds with water following large precipitation events. At the time of site visit (April 2008), sparse cover (less than 5 percent cover) of the annual forb Russian-thistle or tumbleweed and the perennial forb narrowleaf globemallow was emerging on the 2.8 acres examined in the survey corridor (see **Figure 4-27**). Dead stems from the previous year's growth indicated that low to moderate cover (up to 15 to 20 percent cover) by Russian-thistle could occur on this site. A single honey mesquite shrub provided sparse cover within this depression. The soils of this site are highly erosive with a texture of fine clay and silt and are apparently quite alkaline; water and wind erosion of these soils during construction could occur and could affect adjacent drainages with fine sediments. Equipment would have difficult access across this area when the soils are saturated and would damage the playa bottom with tire ruts.

Figure 4-27. Representative Photographs of Russian-thistle Playa Habitat

Common Cocklebur Semi-natural Herbaceous Vegetation

An (b) (7)(E) occurs on 0.3 acre across an access road and ponds water on both sides of the road when sufficient runoff is collected (see **Figure 4-28**). The annual forb common cocklebur had become established and provided moderate cover (35 percent) across the (b) (7)(E) bottom. Associated mesic grasses included Johnsongrass and scratchgrass that provided low cover (5 percent cover) along the (b) (7)(E) margin. The dwarf-shrub little-head snakeweed occurred on the (b) (7)(E) margin above the level of inundation and contributed sparse cover. This site could have difficult access when ponded water is present following precipitation events.

Figure 4-28. Representative Photographs of Common Cocklebur (b) (7)(E) Habitat

4.1.11 Other Nonnative Herbaceous Vegetation Alliances and Associations

Bermuda Grass Semi-natural Herbaceous Vegetation

A small irrigated pasture characterized by the nonnative Bermuda grass was maintained at the (b) (7)(E), located adjacent to (b) (7)(E) the international border (see **Figure 4-29**). The pasture occupied 0.3 acre in the survey corridor, provided 40 to 80 percent cover of Bermuda grass, and supported annual forbs along its edges and in bare patches. The annual forbs provided sparse cover and included Russian-thistle or tumbleweed, horsenettle, whitetop, and London rocket. A sprinkler irrigation system was installed that used rotating Rain-Bird style heads for water distribution.

Figure 4-29. Representative Photographs of Bermuda Grass Irrigated Pasture Habitat

4.2 Plant Species Identified

A list of plant species prepared during the field surveys and annotated for nonnative and Arizona protected status is provided in **Table 4-2**. An early spring survey identified 125 taxa.

Table 4-2. Plant Species List, Relative Abundance in the Survey Corridor, and Habitat for (b) (7)(E) Station, FV-1b

Species / Common Name	Distribution	Location / Habitat
Trees and Tall Shrubs		
Baccharis pteronoides / Yerba de Pasmo	Rare	(b) (7)(E)
Baccharis sarothroides / Desert broom	Uncommon	Desert washes, roadsides
Celtis reticulata / Netleaf hackberry	Rare	Desert washes, springs
Chilopsis linearis / Desert willow[4]	Rare	(b) (7)(E)
Fouquieria splendens / Ocotillo[3]	Common	Rocky slopes, alluvial plains
Fraxinus velutina / Green ash	Rare	(b) (7)(E)
Juniperus monosperma / One-seed juniper	Rare	Limestone outcrops, (b) (7)(E)
Populus fremontii / Fremont cottonwood	Rare	(b) (7)(E), springs
Prosopis glandulosa / Honey mesquite[4,5]	Abundant	Rocky slopes, alluvial plains, desert washes, swales, cienegas, playas
Salix gooddingii / Goodding willow	Rare	(b) (7)(E)
Short and Dwarf Shrubs		
Acacia constricta / Whitethorn	Abundant	Most upland habitats
Acacia millefolia / Acacia	Uncommon	Rocky slopes
Agave palmeri / Century plant[3]	Uncommon	Rocky slopes
Agave parryi / Parry agave[3]	Uncommon	Rocky slopes
Agave sp. / Agave[3]	Rare	Limestone bedrock
Anisacanthus thurberi = Justicia californica / Chuparosa	Uncommon	Desert washes
Atriplex canescens / Fourwing saltbush	Common	Rocky slopes, alluvial fans, desert washes
Bebbia juncea / Rush bebbia	Rare	Desert washes
Brickellia californica / Brickelbush, Pachaba	Rare	Rocky slopes, Desert washes
Bumelia lanuginosa / Buckthorn	Rare	Rocky slopes
Clematis drummondii / Texas virgin's bower	Rare	Desert wash
Condalia spathulata / Squawbush	Uncommon	Rocky slopes, alluvial fans
Dalea formosa / Feather peabush	Uncommon	Rocky slopes
Dasylirion wheeleri / Sotol[3]	Uncommon	Rocky slopes, limestone bedrock

Species / Common Name	Distribution	Location / Habitat
Short and Dwarf Shrubs (continued)		
Dyssodia acerosa / Spiny dogweed, Prickly fetid marigold	Uncommon	Rocky slopes
Echinocereus engelmannii / Strawberry hedgehog[3]	Rare	Rocky slopes
Echinocereus pectinatus / Rainbow cactus[3]	Rare	Rocky slopes, alluvial fans
Encelia farinosa / Brittlebush	Rare	Rocky slopes
Ephedra trifurca / Long-leaved jointfir, Mormon-tea	Rare	Rocky slopes
Flourensia cernua / Tarbush	Abundant	Rocky slopes, alluvial fans, plains, desert washes
Gutierrezia microcephala / Little-head snakeweed	Common	Rocky slopes, alluvial fans, plains, desert washes
Hymenoclea monogyra / Burro bush	Uncommon	Creek bed
Hymenoclea salsola / Cheesebush	Uncommon	Desert washes
Koeberlinia spinosa / Junco, Allthorn	Rare	Limestone outcrops
Larrea tridentata / Creosotebush	Abundant	Most upland habitats
Mammillaria sp. / Fishhook cactus[3]	Rare	Rocky slopes, alluvial fans
Menodora scabra / Rough menodora	Uncommon	Limestone outcrops
Mimosa biuncifera / Wait-a-minute	Uncommon	Rocky slopes
Mortonia scabrella / Mortonia	Uncommon	Limestone outcrops and colluvium
Opuntia leptocaulis / Desert Christmas cactus[3]	Uncommon	Rocky slopes
Opuntia phaeacantha / Engelmann prickly pear[3]	Common	Rocky slopes, alluvial fans
Opuntia ramosissima / Diamond cholla[3]	Uncommon	Rocky slopes
Opuntia spinosior / Cane cholla[3]	Uncommon	Rocky slopes
Opuntia violacea / Purple prickly pear[3]	Uncommon	Rocky slopes
Parthenium incanum / Mariola	Abundant	Most upland habitats
Peniocereus greggii / Deerhorn cactus[3]	Rare	Volcanic cobble slope
Platanus wrightii / Arizona sycamore	Rare	(b) (7)(E) bottom
Quercus sp. / Oak	Rare	Limestone outcrop
Rhus microphylla / Littleleaf sumac	Uncommon	Desert washes, swales, creeks, draws
Suaeda torreyana / Seepweed	Rare	Cienega

Species / Common Name	Distribution	Location / Habitat
Short and Dwarf Shrubs (continued)		
Tiquilia canescens = Coldenia canescens / Dog's ear	Abundant	Most upland habitats
Yucca elata / Soaptree yucca[3]	Uncommon	Sandy plains
Yucca schottii / Yucca[3]	Uncommon	Rocky slopes, alluvial fans
Ziziphus obtusifolia = Condalia lycioides / Graythorn	Uncommon	Rocky slopes
Graminoids		
Aristida adscensionis / Annual threeawn	Uncommon	Alluvial fans, plains, disturbed sites
Aristida purpurea / Purple threeawn	Uncommon	Rocky slopes
Aristida hamulosa / Hook threeawn	Common	Rocky slopes, alluvial fans, plains
Bouteloua eriopoda / Black grama	Uncommon	Rocky slopes
Bromus wildenowii = Bromus catharticus / Rescue grass	Rare	Spring-fed drainage
Carex sp. / Sedge	Rare	Spring-fed drainage
Chloris virgata / Windmill grass[1]	Rare	Spring-fed drainage
Cynodon dactylon / Bermudagrass[1]	Rare	Irrigated pasture
Distichlis spicata / Saltgrass	Rare	Cienega
Erioneuron pulchellum = Tridens pulchellus / Fluffgrass	Abundant	Most upland habitats
Hilaria mutica / Tobosa	Common	Most upland habitats
Hordeum jubatum / Foxtail barley[1]	Rare	Spring-fed drainage
Hordeum leporinum / Wild barley[1]	Rare	Spring-fed drainage
Juncus balticus / Baltic rush	Rare	Spring-fed drainage
Leptochloa dubia / Sprangletop	Uncommon	Rocky slopes
Muhlenbergia asperifolia / Scratchgrass	Rare	Excavated site
Muhlenbergia porteri / Bush muhly	Uncommon	Rocky slopes
Polypogon monspeliensis / Rabbitsfoot grass[1]	Rare	Spring-fed drainage
Schismus barbatus / Mediterranean grass[1]	Uncommon	Alluvial fans, plains
Scirpus americanus = Schoenoplectus pungens / Three-square bulrush	Rare	(b) (7)(E) spring-fed sites, ponds

Species / Common Name	Distribution	Location / Habitat
Graminoids (continued)		
Schizachyrium scoparium / Little bluestem	Rare	rock outcrops
Sorghum halepense / Johnsongrass[1]	Rare	Spring-fed drainage
Sporobolus airoides / Alkali sacaton	Common	Desert washes, swales
Sporobolus cryptandrus / Sand dropseed	Uncommon	Desert washes, sandy areas
Sporobolus giganteus / Giant dropseed	Common	Desert washes
Typha domingensis / Southern cattail	Rare	(b) (7)(E) springs, ponds
Forbs		
Acourtia nana = *Perezia nana* / Dwarf desert holly	Common	Most upland habitats
Allionia incarnata / Trailing windmills	Uncommon	Rocky slopes, desert washes
Amaranthus palmeri / Palmer's amaranth[1]	Rare	Cienega
Ambrosia confertiflora = *Franseria confertiflora* / Slimleaf bursage	Rare	Cienega
Argemone sp. / Prickly poppy	Rare	(b) (7)(E)
Astragalus sp. / Milkvetch	Rare	Desert wash
Atriplex sp. / Prostrate saltbush	Rare	Cienega, playa, irrigated pasture
Baileyia multiradiata / Desert marigold	Uncommon	Alluvial fans, plains, bladed site
Cardaria sp. / Whitetop[1]	Uncommon	Irrigated pasture
Centaurea melitensis / Malta starthistle	Rare	Spring-fed drainage
Chenopodium fremontii / Fremont goosefoot	Rare	Cienega, Irrigated pasture
Cryptantha sp. / Cryptantha	Common	Most upland habitats
Cucurbita foetidissima / Buffalo gourd	Rare	Desert wash
Cymopterus multinervatus / Purple cymopterus	Rare	Rocky slopes
Datura meteloides / Sacred datura	Rare	Desert washes
Descurainia pinnata / Tansy mustard[1]	Rare	Irrigated pasture, disturbed roadside
Eriastrum diffusum / Miniature wool-star	Uncommon	Rocky slopes, alluvial fans
Erodium cicutarium / Filaree[1]	Rare	Irrigated pasture

Species / Common Name	Distribution	Location / Habitat
Forbs (continued)		
Euphorbia albomarginata / Rattlesnake weed	Rare	Spring-fed drainage
Haplopappus spinosus / Golden aster	Uncommon	Rocky slopes
Helianthus annuus / Common sunflower	Uncommon	Cienega, playa, spring-fed drainage
Lappula redowskii / Stickweed	Uncommon	Rocky slopes, cienega, disturbed roadsides
Lepidium thurberi / Thurber's peppergrass	Rare	Plains
Medicago lupulina / Black medic[1]	Rare	Spring-fed drainage
Melilotus officianalis / Yellow sweetclover[1]	Rare	Spring-fed drainage
Mentzelia albicaulis / White stem stickleaf	Uncommon	Rocky slopes, desert washes
Mentzelia pumila / Stickleaf	Uncommon	Rocky slopes
Notholaena sp. / Cloak fern	Rare	Limestone bedrock
Pectis fillipes / Threadstem cinchweed	Rare	Rocky slopes
Penstemon superbus / Superb penstemon	Rare	Desert washes
Penstemon sp. / Beardtongue	Rare	Limestone bedrock
Phacelia coerulea / Blue scorpionweed	Uncommon	Desert washes
Phoradendron californicum / Mistletoe	Uncommon	Honey mesquite trees and shrubs, many habitats
Phoradendron flavescens / Mistletoe	Rare	Arizona sycamore trees, desert washes
Plantago patagonica / Plantain	Common	Rocky slopes, alluvial fans, plains
Proboscidea parviflora / Devil's claw	Rare	Alluvial plains, desert washes
Rumex hymenosepalus / Canaigre	Rare	Cienega
Salsola iberica / Russian-thistle[1]	Rare	Playa, disturbed roadsides
Salvia henryi / Crimson sage	Uncommon	Desert washes
Selaginella sp. / Club moss	Rare	Limestone bedrock
Silene antirrhinum / Sleepy catchfly[1]	Uncommon	Most upland habitats
Sisymbrium irio / London rocket[1]	Rare	Irrigated pasture, disturbed roadsides
Forbs (continued)		

Species / Common Name	Distribution	Location / Habitat
Solanum eleagnifolium / Horse nettle[1]	Rare	Desert washes, irrigated pasture, cienega
Sphaeralcea angustifolia / Narrowleaf globemallow	Uncommon	Rocky slopes
Sphaeralcea laxa / Caliche globemallow	Rare	Playa
Verbena gooddingii / Goodding (Dakota) verbena	Uncommon	Desert washes
Verbesina encelioides / Cowpen daisy	Rare	Irrigated pasture
Xanthium strumarium / Common cocklebur[1]	Rare	Excavated depression

Notes:

[1] Nonnative species (noxious weeds were not identified within the corridor).

[2] Highly Safeguarded Protected Native Plants (this category was not identified within the corridor): species of native plants whose prospects for survival in Arizona are in jeopardy or are in danger of extinction).

[3] Salvage Restricted Protected Native Plants (species of native plants that are subject to damage by theft or vandalism).

[4] Salvage Assessed Protected Native Plants (species of native plants that have a sufficient value if salvaged to support the cost of salvage).

[5] Harvest Restricted Protected Native Plants (species of native plants that are subject to excessive harvesting or overcutting because of their intrinsic value).

4.3 Survey Corridor Characteristics and Description of Habitat Quality

To ensure the most recent data were acquired for rare species analyses, e²M requested Element Occurrence Data from NatureServe Central Databases in Arlington, Virginia, through a referral from the USFWS (NatureServe and e²M 2007a). Additionally, rare species data were acquired from AZGFD and USFWS at Project inception. General descriptions of the habitat quality as it relates to rare plant species and the landscape characteristics of the survey cooridor are provided herein and are based on field observations, personal communications, and the literature.

SECTION FV-1b

County: (b) (7)(E)

Potential Listed Plant Occurrence: *Spiranthes delitescens* (Canelo Hills or Madrean ladies'-tresses) (Federal [FE], state [HS])
Coryphantha robbinsorum (Cochise pincushion cactus) (Federal [FE], state [HS])
Lilaeopsis schaffneriana ssp. *recurva* (Huachuca water umbel) (Federal [FE], state [HS])

Erigeron lemmonii (Lemmon fleabane) (Federal [FC], state [HS])

Listed Plants Observed: None

Suitable Listed Plant Habitat Present: Possible habitat (perennial low gradient streams and wetlands) for the Huachuca water umbel occurs adjacent to (b) (7)(E) (b) (7)(E).

If so, Habitat Quality: Fair to Good

Section Habitat Description: This section includes approximately (b) (7)(E) (b) (7)(E) (b) (7)(E) The western portion of section FV-1b occurs on steep slopes dominated by ocotillo, transitioning to alluvial fans and plains characterized by creosotebush, mariola, tarbush, and honey mesquite shrubs. A few slopes are armored by volcanic gravel and cobble where patches of tobosa occur amid shrublands dominated by honey mesquite and/or creosotebush. Gullies and desert washes commonly occur in this terrain. Within (b) (7)(E) lowland habitats including irrigated pasture, go-back fields, and extensive stands of honey mesquite with four-wing saltbush in the understory, and riparian forests and woodlands occur. Particularly good riparian forest habitats occupy (b) (7)(E) and thick honey mesquite woodlands occur along (b) (7)(E) The easternmost portion of the FV-1b survey cooridor consists of ridges and drainages supporting creosotebush and mariola shrublands, honey-mesquite-dominated lower slopes and drainage bottoms, and stands of alkali sacaton in narrow drainages. The road providing access between (b) (7)(E) and (b) (7)(E) crosses exposed Permian limestone, and the shrubland is dominated by mortonia, tarbush, and mariola. This access road traverses the only small trees of one-seed juniper and shrubs of oak and junco observed in the survey corridor.

- Madrean ladies'-tresses occur in the (b) (7)(E) in cienegas with finely grained, highly organic, saturated soils. This habitat does not occur within the survey corridor.

Cochise pincushion cactus occurs on gray (Permian) limestone hills that support semi-desert grassland with small shrubs, agave, cacti, and grama grass. It does not co-occur with mortonia shrubs on lower slopes (USFWS 1993). Permian limestone outcrops exposed along an paccess road on the eastern end of FV-1b survey corridor were searched for Cochise pincushion cactus, but none were observed and mortonia was a dominant shrub. There are no limestone outcrops within the Project area. The hill or small mountain (b) (7)(E) (b) (7)(E) does have appropriate Permian limestone habitat and does support a semi-desert grassland community on its upper one-fourth; however, there will be no construction and hence no impact to this potential habitat for the Cochise pincushion cactus.

Huachuca water umbel occurs in cienegas, perennial low gradient streams, and wetlands. (b) (7)(E) and one nearby spring (b) (7)(E) provide this habitat and represent potential sites for Huachuca water umbel establishment.

Lemmon fleabane occurs in pine-oak woodlands in rock crevices, on ledges, and among boulders in canyon bottoms. This habitat does not occur within the survey corridor.

4.4 Wetlands and Waters of the United States

Wetlands and waters of the United States can be confusing terms and are defined here for the convenience of document users. The USACE has jurisdiction to protect wetlands under section 404 of the Clean Water Act using the following definition:

> *. . . areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 Code of Federal Regulations [CFR] 328.3[b]). Wetlands generally include swamps, marshes, bogs, and similar areas.*

Wetlands have three diagnostic characteristics that include (1) more than 50 percent of the dominant species present must be classified as obligate, facultative wetland; or facultative, (2) the soils must be classified as hydric; and (3) the area is either permanently or seasonally inundated (Environmental Laboratory 1987).

Waters of the United States are defined under 33 *United States Code* (U.S.C.) 1344, as follows:

a. The term “waters of the United States” means
    1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
    2. All interstate waters including interstate wetlands;
    3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
        i. Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
        ii. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

iii. Which are used or could be used for industrial purpose by industries in interstate commerce;

4. All impoundments of waters otherwise defined as waters of the United States under the definition;
5. Tributaries of waters identified in paragraphs (a) (1)-(4) of this section;
6. The territorial seas;
7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) (1)-(6) of this section.
8. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act (CWA), the final authority regarding CWA jurisdiction remains with the EPA.
9. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the United States.

b. The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

c. The term "adjacent" means bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are "adjacent wetlands."

d. The term "high tide line" means the line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

e. The term "ordinary high water mark" means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the

presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

The term "tidal waters" means those waters that rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by hydrologic, wind, or other effects.

The survey corridor lies within (b) (7)(E), which includes approximately 250,000 acres (USEPA 2008; NRCS 2008). The watershed occurs in the (b) (7)(E) The (b) (7)(E) and artesian aquifer cover approximately (b) (7)(E)

Generally, the (b) (7)(E) an asymmetric extensional basin that experienced extensive mafic volcanism in the Cenozoic Period (Earman et al. 2002). On a large scale, it lies within the Rio Yaqui Watershed (USFWS 1994a). In Arizona, the basin's major fault lies on the western side of the basin, and in Sonora, the Pitaycachi Fault occurs on the eastern side of the basin (Earman et al. 2002). In Arizona, the bedrock forms a half graben down-dropped on the western side by antithetic normal faults with structural highs formed by transfer faults. The heterogenous basin fill, which contains numerous basalt interbeds, was deposited predominantly in alluvial fan and alluvial slope environments. Generally, the basin structure does not have a large effect on groundwater flow as most water is transmitted through paleochannel deposits that make up a relatively small portion of the aquifer.

Arizona water rights (b) (7)(E) date from 1882 for unlitigated surface water rights and from 1903 for groundwater permits (USFWS 1995). Surface water rights include (1) (b) (7)(E) (100 acre-feet per year); (2) (b) (7)(E) (b) (7)(E) (19 gallons per minute); (3) (b) (7)(E) (15 gallons per minute); (4) (b) (7)(E) (9.5 gallons per minute); (5) (b) (7)(E) (49 gallons per minute); and (6) (b) (7)(E) (3.8 gallons per minute). There are ten permitted groundwater wells on the refuge that each are adjudicated for 250 acre-feet of water production annually.

4.4.1 Field Evaluation Summary

Observations and initial identification of potential wetlands and waters of the United States for the survey corridor were recorded during the April/May 2008 field inventory.

Field surveys were conducted on June 10 through 13, 2008, to delineate jurisdictional wetlands and other Waters of the United States within the survey corridor. Delineations were also conducted along access roads and staging

areas associated with the fence alignments. Formal delineations were conducted within a 150-foot corridor associated with the fence alignments, 60 feet to either side of the center line of access roads, and within staging areas.

Determination of the occurrence and extent of jurisdictional wetlands and other Waters of the United States were based on the application of procedures established in the USACE *Wetlands Delineation Manual*, Technical Report Y–87–1 (USACE 1987) and the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region,* Technical Report ERDC/EL TR-06-16 (USACE 2006). Determination of the occurrence of jurisdictional wetlands was based on the presence or absence of hydrophytic (wetland) vegetation, hydric (wetland) soils, and wetland hydrology. The presence of all three of the criteria is necessary for an area to be designated as a jurisdictional wetland under normal conditions.

Determination of the extent of jurisdictional washes and other Waters of the United States in the survey corridor was based on characterization of the landward extent of the ordinary high water mark (OHM). Indicators used to determine the occurrence and extent of jurisdictional washes included the presence of developed channels, typically 2 feet or greater in width; the occurrence of an OHM; the absence of fine sediments along flow paths; distinct changes in the vegetative assemblage or larger or more dense vegetation than surrounding areas; the presence of cut banks; the presence of litter, debris, or wrack lines; occurrence of desiccation cracks or other indicators of hydrology; and other indicators of the occurrence of intermittent water flow regimes.

All wetlands and other Waters of the United States within the survey corridor were delineated.

Table 4-3 provides wetland and other Waters of the United States types and delineated acreages within a 150-foot corridor associated with the fence alignments, 60 feet to either side of the center line of access roads, or within planned staging areas; and potential impact acreages in Section FV-1b. A 60-foot impact corridor to the north of the fence alignment or adjacent to access roads is considered the maximum width of potential impact associated with implementing the Project. All wetland or other Waters of the United States acreages within staging areas are included as potential impact areas. The following text provides general descriptions of wetlands and other Waters of the United States identified within the Project assessment areas in Section FV-1b.

Table 4-3. Delineated Acreages, General Locations and Potential Impact Acreage of Wetlands and Other Waters of the United States in (b) (7)(E) AZ Section FV-1b

WL ID	Wetland or Other WOUS Type	General Location	Delineated Area (acres)	Potential Impacts (acres)
(b) (7)(E)	Wash	(b) (7)(E)	5.14	1.75
	Wash			
	Wash		0.27	0.07
	Wash		0.18	0.07
	Wash		0.28	0.09
	Wash		0.26	0.07
	Wash		0.98	0.31
	Wash		0.43	0.20
	Wash		4.88	1.66
	Wash		0.17	0.08
	Wash		0.29	0.17
	Wash		0.46	0.15
	Wash		0.25	0.01
	Wash		6.07	0.42
	Wash		0.55	0.29
	Emergent wetland		0.11	0.01
	Riverine and palustrine forested wetland		1.74	0.35
	Wash		1.92	1.31

WL ID	Wetland or Other WOUS Type	General Location	Delineated Area (acres)	Potential Impacts (acres)
(b) (7)(E)	Wash	(b) (7)(E)	1.33	0.36
	Wash		1.07	0.25
	Wash		0.27	0.11
	Wash		0.44	0.15
	Wash		0.61	0.18
	Wash		0.30	0.15
	Wash		0.21	0.12
	Wash		0.46	0.09
	Wash		0.49	0.12
	Wash		3.68	2.54
	Wash		0.26	0.10
	Wash		0.45	0.22
	Wash		0.38	0.05
	Wash		0.32	0.16
	Wash		0.17	0.03
	Wash		0.19	0.08
	Wash		0.14	0.07
	Wash		0.50	0.10

WL ID	Wetland or Other WOUS Type	General Location	Delineated Area (acres)	Potential Impacts (acres)
(b) (7)(E)	Wash	(b) (7)(E)	0.55	0.08
	Wash		0.69	0.34
	Wash		1.24	0.84
	Wash		0.13	0.13
	Wash		0.15	0.04
Totals			**38.01**	**13.32**

Based on the field surveys, 37 ephemeral wash channels and 2 vegetated wetlands occur within the (b) (7)(E) corridor associated with the fence alignments, (b) (7)(E) to either side of the center line of access roads, or within staging areas. Of the 37.87 total delineated acres of wetlands and other Waters of the United States, 13.28 acres occur within the potential impact areas. Wetlands and other Waters of the United States delineated in Section FV-1b were designated as (b) (7)(E) .

(b) (7)(E) is characterized by two ephemeral wash channels ((b) (7)(E)) that flow (b) (7)(E) along the U.S./Mexico international border. (b) (7)(E) (b) (7)(E) . (b) (7)(E) is located primarily (b) (7)(E) Channel width at base in the two channels ranges from 2 feet to 5 feet with near-vertical banks. Vegetation characterizing the banks of the two channels is characterized by creosotebush (*Larrea tridentate*), honey mesquite (*Prosopis glandulosa*) and littleleaf sumac (*Rhus microphylla*).

(b) (7)(E) are ephemeral washes that cross the (b) (7)(E) The access road is located approximately (b) (7)(E) . (b) (7)(E) is the downstream component of (b) (7)(E) join (b) (7)(E) and then join with (b) (7)(E) (b) (7)(E) . (b) (7)(E) have wide shallow channels (b) (7)(E) that range from 12 to 15 feet in width at their base. The banks range from approximately 1 to 2 feet in height with bank slopes ranging from 45 percent to near vertical. (b) (7)(E) has a narrow channel that ranges from 2 to 4 feet in width at base with approximately 2-foot-high banks and slopes ranging from 45 percent to near vertical. Vegetation characterizing the banks of the three wash channels includes littleleaf sumac, honey mesquite, desert broom (*Baccharis sarothroides*), whitethorn acacia (*Acacia constricta*), tar bush (*Flourensia cernua*), little-head snakeweed (*Gutierrezia microcephala*), and Engelmann prickly-pear (*Opuntia engelmannii*).

(b) (7)(E) are ephemeral washes that cross (b) (7)(E) (b) (7)(E) is a narrow wash with an approximately 2-foot-wide channel at base and near-vertical 2-foot-high banks (b) (7)(E) The channel directs flows to the southeast. Vegetation on the wash banks is characterized by honey mesquite and Engelmann prickly-pear. (b) (7)(E) is a wide, incised ephemeral wash with an approximately 25- to 35-foot-wide channel at base. (b) (7)(E) the channel is characterized by near vertical 6 to 8 foot high banks on its south side and 2 foot high banks with 45 percent slopes on the north side. The channel flows (b) (7)(E) Vegetation occurring on the wash banks in proximity to the access road and fence alignment is characterized by honey mesquite.

(b) (7)(E) is a narrow ephemeral wash that (b) (7)(E) The wash is characterized by a 4-foot-wide channel at base and near-vertical 3-foot banks. Vegetation of the banks of the wash is characterized by honey mesquite.

(b) (7)(E) is an ephemeral wash that drains (b) (7)(E) The wash crosses (b) (7)(E) Channel width at base ranges from approximately 15 feet at the confluence with (b) (7)(E) to approximately 3 feet to 8 feet at the (b) (7)(E) (b) (7)(E). Channel banks are near vertical and range from approximately 3 feet to 8 feet in height at Project alignment crossing. Vegetation on the banks of (b) (7)(E) is characterized by honey mesquite, littleleaf sumac, desert broom, and creosotebush.

(b) (7)(E) are tributary washes that drain into (b) (7)(E) is a narrow ephemeral wash that directs flows (b) (7)(E) discharging into (b) (7)(E) direct flows (b) (7)(E) where they discharge into (b) (7)(E) directs flows (b) (7)(E) discharges into (b) (7)(E) (b) (7)(E) Channel widths at base range from 3 feet to 5 feet in the survey corridor and the channel banks range from 1 to 3 feet in height with bank slopes ranging from 45 percent to near vertical. Vegetation characterizing the wash banks is characterized by white thorn acacia, littleleaf sumac, and creosotebush.

(b) (7)(E) is (b) (7)(E) a large, wide, ephemeral wash with high, near-vertical banks on outside bends and well-developed alluvial bars on inside bends. The wash directs flows (b) (7)(E). The channel width at base ranges from approximately 400 feet (b) (7)(E) to approximately 160 feet (b) (7)(E). Bank

heights on outside bends exceed 20 feet in places. Honey mesquite and desert broom characterize the vegetation of the wash banks and alluvial bar deposits.

(b) (7)(E) is an ephemeral wash that is the downstream segment of a wash that crosses through (b) (7)(E). Most of the historical natural flow in the wash has probably been cut off as a result of an upstream impoundment constructed (b) (7)(E). The wash within the Project alignment has been disturbed and is characterized an approximately 30-foot-wide channel at base, with 2-foot-high, non-distinct banks having 25 percent slopes. Vegetation on the banks of the wash is characterized by honey mesquite. Several species of grasses occur in the wash channel.

(b) (7)(E) is a palustrine emergent wetland located along the Project alignment in the (b) (7)(E) The small emergent wetland is characterized by a near monotypic stand of three square (*Scirpus olneyi*). A few Goodding's willows (*Salix nigra* var. *goodingii*) and Freemont cottonwoods (*Populus fremontii*) occur on the perimeter of the wetland. A vehicle fence has been placed within the boundaries of the wetland by the USFWS.

(b) (7)(E) is a riverine and palustrine forested wetland associated with (b) (7)(E) a perennial stream that directs flows (b) (7)(E) has a deeply incised central channel that is approximately 60 feet wide at base. The central channel was maintaining flow at the time of the site survey. Base flow in the channel is supported by upstream springs. The riverine component of (b) (7)(E) occurs in association with the central channel. Vegetation occurring in association with the riverine wetland is characterized by southern cattail (*Typha domingensis*) and three square. The channel is bordered by a low terrace. The width of the central channel and terrace is approximately 100 feet with near-vertical 10-foot banks bordering the terrace. The palustrine forested component of (b) (7)(E) occurs in association with the terrace. Vegetation occurring in association with the palustrine forested wetland includes Freemont cottonwood and Goodding's willows with some honey mesquite. Vegetation on the upper banks of (b) (7)(E) is characterized by honey mesquite. An impoundment has been constructed across the channel and terrace with gabions. (b) (7)(E)

(b) (7)(E) is (b) (7)(E) in proximity to the Project alignment is characterized by a vegetated ephemeral wash with an approximately 75-foot channel width at base. Channel banks are approximately 8 feet in height and vertical. Freemont cottonwood and Goodding's willow occur in association with alluvial bars in the wash and some giant dropseed (*Sporobolus giganteus*) occurs along the base of the channel banks. Vegetation on the wash banks is characterized by honey mesquite. The wash channel and banks have been disturbed at the border as a result of border crossings.

(b) (7)(E) is a deeply incised ephemeral wash that directs flows (b) (7)(E). The channel width at base is approximately 7 feet. Channel banks are

near vertical and are approximately 8 feet in height. Vegetation on the banks of the wash is characterized by white thorn acacia and creosotebush.

(b) (7)(E) is a disturbed ephemeral wash that historically directed flows (b) (7)(E) Flow to the wash has been cut off by an impoundment located approximately 300 feet upstream from the border. (b) (7)(E), the channel base is approximately 20 feet wide. Channel banks have been disturbed and are approximately 3 feet high with 35percent slopes. Giant dropseed and little-head snakeweed occur in the wash channel and vegetation on the banks is characterized by Russian thistle (*Salsola kali*), four-wing saltbush (*Atriplex canescens*), and honey mesquite.

(b) (7)(E) are ephemeral washes that direct flows (b) (7)(E). The two washes join approximately (b) (7)(E). (b) (7)(E) discharges into the main wash channel (b) (7)(E) (b) (7)(E) has an incised channel that is approximately 5 feet wide at base with 5-foot-high banks in the survey corridor. The channel banks slope at approximately 60 percent. (b) (7)(E) has an approximately 20-foot-wide channel at base with 3-foot banks in the survey corridor. The channel banks have 35 percent slopes. Vegetation on the banks of both washes is characterized by honey mesquite, creosotebush, four-wing saltbush, and tar bush.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E). The channel width at base is approximately 4 feet. Channel banks are approximately 4 feet high with 45 percent slopes at the border and become near vertical downstream (b) (7)(E). Evidence of active headwall cutting is present in places along the channel. Vegetation on the banks of the wash is characterized by honey mesquite and white thorn acacia.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E)s. The channel width at base is approximately 8 feet. Channel banks are near vertical and approximately 5 feet in height. Vegetation on the banks of the wash is characterized by honey mesquite, four-wing saltbush, white thorn acacia, and little-head snakeweed.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E). The channel width at base is approximately 2 feet. Channel banks are approximately 4 feet high with 55 percent slopes. The wash in the survey corridor is characterized by two channels with an alluvial island in the center. The channels join (b) (7)(E). Vegetation on the banks of the channels is characterized by honey mesquite, four-wing saltbush, and little-head snakeweed.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E). The channel width at base is approximately 4 feet. Channel banks are approximately 8 feet high with 45 percent slopes. Vegetation on the banks of the wash is characterized by honey mesquite and little-head snakeweed.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E) . The channel widths at base range from approximately 3 to 8 feet. Channel bank heights range from 3 feet to 8 feet with bank slopes ranging from approximately 75 percent to near vertical. Vegetation on the banks of the wash is characterized by honey mesquite, giant dropseed, four-wing saltbush, and little-head snakeweed.

(b) (7)(E) is a narrow ephemeral wash that (b) (7)(E) . The channel width at base is approximately 3 feet. Channel banks are approximately 2 feet high with 45 percent slopes. Vegetation on the banks of the wash is characterized by honey mesquite, littleleaf sumac, and creosotebush.

(b) (7)(E) is an ephemeral wash that (b) (7)(E) . The channel width at base in the staging area is approximately 5 feet. Channel banks are approximately 2 feet high with 45 percent slopes. The channel becomes indistinct and braided where it crosses the border. Vegetation on the banks of the wash is characterized by white thorn acacia, tar bush, creosotebush, giant dropseed, and littleleaf sumac.

(b) (7)(E) is an ephemeral wash that (b) (7)(E) . The channel width at base is approximately 3 feet. Channel banks are approximately 5 feet high with 55 percent slopes. Vegetation on the banks of the wash is characterized by tar bush, littleleaf sumac, white thorn acacia, purple three awn (*Aristida purpurea*), and little-head snakeweed.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E) . The channel base is approximately 2 feet wide (b) (7)(E) The channel banks are near vertical and approximately 2 feet high. Approximately 60 feet downstream of the border the channel width at base is approximately 4 feet with 1-foot near-vertical banks. Vegetation on the banks of the wash is characterized by honey mesquite, littleleaf sumac, tar bush, creosotebush, and giant dropseed.

(b) (7)(E) is an ephemeral wash that directs flows (b) (7)(E) . The channel width at base is approximately 4 feet. Channel banks are approximately 2 feet high with 45 percent slopes. Vegetation on the banks of the wash is characterized by creosotebush, white thorn acacia, littleleaf sumac, and tar bush.

(b) (7)(E) is a narrow ephemeral wash that (b) (7)(E) . The channel width at base is approximately 3 feet. Channel banks are approximately 2 feet high with 35 percent slopes. Vegetation on the banks of the wash is characterized by tar bush, littleleaf sumac, white thorn acacia, and creosotebush.

(b) (7)(E) is a narrow ephemeral wash that (b) (7)(E) . The channel width at base is approximately 3 feet. Channel banks are approximately 2 feet high with 45 percent slopes. Vegetation on the banks of the wash is characterized by creosotebush, tar bush, littleleaf sumac, little-head snakeweed, and white thorn acacia.

(b) (7)(E) is a narrow ephemeral wash that directs flows (b) (7)(E). The channel width at base is approximately 2 to 3 feet. Channel banks are approximately 4 feet high with 60 percent slopes. Vegetation on the banks of the wash is characterized by creosotebush, littleleaf sumac, white thorn acacia, little-head snakeweed, honey mesquite, and giant dropseed.

(b) (7)(E) is a narrow ephemeral wash that directs flows (b) (7)(E). (b) (7)(E) is comprised of two channels (b) (7)(E) The western channel directs flows to (b) (7)(E). The western channel's width at base is approximately 2 feet. Channel banks in the western channel are approximately 4 feet high with 45 percent slopes. The eastern channel directs flows (b) (7)(E). The channel width at base is approximately 2 feet. Channel banks in the eastern channel are near vertical and approximately 4 feet in height. Vegetation on the banks of both wash channels is characterized by white thorn acacia, creosotebush, and little-head snakeweed.

(b) (7)(E) is a narrow ephemeral wash downstream of an impoundment. The channel directs flows (b) (7)(E) Historical flow in the wash has been cut off by the impoundment and the channel has been disturbed. The channel width at base is approximately 20 feet. Channel banks are approximately 3 feet high with 35 percent slopes. Vegetation on the banks of the wash is characterized by Russian thistle, creosotebush, four-wing saltbush, honey mesquite, little-head snakeweed, and giant dropseed.

(b) (7)(E) is a wide ephemeral wash (b) (7)(E) The channel width at base is approximately 40 feet. Channel banks are near vertical and 3 feet to 6 feet in height. Vegetation on the banks of the wash is characterized by burrobush (*Hymenoclea monogyra*), little-head snakeweed, western sycamore (*Platanus wrightii*), velvet ash (*Fraxinus velutina*), western hackberry (*Celtis reticulata*), mule fat (*Baccharis salicifolia*), and honey mesquite.

(b) (7)(E) is an ephemeral wash that directs flows(b) (7)(E). The wash was cut to direct storm water flows (b) (7)(E) d into (b) (7)(E). The channel width at base is approximately 12 to 15 feet. The channel banks are near vertical and approximately 3 feet in height. Vegetation on the banks of the wash is characterized by western hackberry, western sycamore, burrobush, and little-head snakeweed.

(b) (7)(E) is(b) (7)(E) extension of (b) (7)(E) that was evaluated independently due to a change in alignment. (b) (7)(E) has similar vegetation as W38 and ranges from 12 to 20 feet in width. (b) (7)(E) is north of the gated dirt road in (b) (7)(E); (b) (7)(E) is the area south.

4.4.2 Wetlands and Other Waters of the United States Vegetation Summary

Wetlands and other Waters of the United States delineated within the survey corridor included one palustrine emergent habitat, one palustrine

forested/riverine, a palustrine emergent habitat, and 37 ephemeral washes. The characteristic vegetation species for each wetland type sampled and delineated during the April/May 2008 field inventory are presented below by stand physiognomy.

4.4.3 Forest and Woodland Palustrine Forested

Four forested and woodland palustrine forested plant communities are found in the survey corridor. They include (1) Fremont Cottonwood – Goodding Willow Forest; (2) Fremont Cottonwood – Honey Mesquite Forest; (3) Arizona Sycamore – Fremont Cottonwood / Honey Mesquite Woodland; and (4) Honey Mesquite / Alkali Sacaton Woodland.

4.4.4 Shrubland

Two shrubland plant communities are found in the survey corridor. They include (1) Seepwillow – Burro Bush Shrubland; and (2) Honey Mesquite – Littleleaf Sumac Shrubland.

4.4.5 Herbaceous Palustrine Emergent

Three herbaceous palustrine emergent plant communities are found in the survey corridor. They include (1) Alkali Sacaton Herbaceous Vegetation; (2) Wild Barley / Honey Mesquite Shrub Herbaceous Vegetation; and (3) Bermuda Grass Herbaceous Vegetation.

4.4.6 Wetlands Soil Summary

Soils identified within vegetated wetlands in FV-1b exhibited hydric soil characteristics.

4.5 Noxious Weeds and Invasive Nonnative Plant Species

Noxious weeds have been addressed nationally under Public Law 108-412 (U.S.C. 2004) “Subtitle E – Noxious Weed Control and Eradication.” The Arizona legislature addressed noxious weeds under Title 3 – Agriculture; Chapter 2 – Regulatory Provisions; Article 1 – Dangerous Plant Pests and Diseases; Section 3-205.01 – Summary abatement of noxious weeds, crop pests, or diseases under preapproved programs (AZDA 2008). The survey corridor does not support Federal-listed (USDA 2006) noxious weeds. One state-listed noxious weed, a species of whitetop, occurred on the edges of the irrigated pasture of the (b) (7)(E) (AZDA 2008a). Eighteen nonnative plant species were observed on-site (see **Table 4-2**); thirteen were annuals and five were biennial or perennial. All nonnative species occurred on disturbed sites receiving higher moisture amounts than normally occur in this region; the sites included roadsides, excavated areas, sandy desert wash bottoms, and irrigated pasture.

In general, nonnative noxious and invasive plant species represent a serious management concern and their inventory, monitoring, and control can be expensive for land managers. Nonnative species usually lower the value of wildlife habitat and they increase with disturbance, including livestock grazing and road maintenance. Once inventoried, methods commonly used to control nonnative species include biological, mechanical, and chemical. Controls must be ongoing to be effective in reducing, but only rarely eliminating, nonnative plant species.

4.6 Protected Native Plants

The Arizona Department of Agriculture (AZDA) oversees rules associated with the use and harvest of native plants, including protected native plant species (see **Table 4-2**) (AZDA 2008b, 2008c). Four categories of protected native plants have been established by the AZDA (2008c):

1. Highly Safeguarded – prospects for survival in Arizona are in jeopardy or are in danger of extinction.
2. Salvage Restricted – subject to damage by theft or vandalism.
3. Salvage Assessed – have sufficient value if salvaged to support the cost of salvage.
4. Harvest Restricted – subject to excessive harvesting or overcutting because of their intrinsic value.

There were no highly safeguarded protected native plants observed within the (b) (7)(E) survey corridor. Fifteen species of "salvage restricted" protected native plants were observed (see **Table 4-2**); the most common of these were pencil cholla, species of yucca, and species of agave. Honey mesquite and desert willow represented the species of "salvage assessed" protected native plants to occur on-site (see **Table 4-2**). Honey mesquite was the single "harvest restricted" protected native plant observed (see **Table 4-2**).

In general, landowners have the right to destroy or remove plants growing on their land, but 20 to 60 days prior to the destruction of any protected native plants landowners are required to notify the AZDA (AZDA 2008). The landowner also has the right to sell or give away any plant growing on the land; however, protected native plants may not be legally possessed, taken, or transported from the growing site without a permit from the AZDA.

4.7 Wildlife and Wildlife Habitat

4.7.1 Introduction

Wildlife habitats of the survey corridor are predominantly (b) (7)(E) shrublands that at the highest elevations are characterized by ocotillo, tarbush, and mortonia. In the middle elevations, creosotebush, tarbush, and honey

mesquite compose the shrubland canopy. The lowest elevations support extensive honey mesquite shrublands and woodlands, gallery forests of Fremont cottonwood and Goodding willow, small stands of grasslands, and forb-dominated go-back agricultural fields.

The entire survey corridor occurs within the (b) (7)(E)

Historically, the basin bottom was a large cienega (marshy wetland) composed of herbaceous vegetation with a few honey mesquite trees and shrubs. Due to ground water pumping, surface water diversion, and farming and ranching pursuits, the basin bottom has become invaded by extensive stands of honey mesquite trees and shrubs. Riparian and wetland plant communities have become established along draws and washes with adequate surface and groundwater flows, on seeps, and adjacent to springs. Limited open water and aquatic habitat occurs. The semi-arid desert uplands contrast sharply with the lowland artesian wells, associated ponds, and mesic habitats.

Recreation (b) (7)(E) and its adjacent environs is centered on wildlife (USFWS 2008). Typical forms include birdwatching, landscape and wildlife photography, and hiking. In season, hunting for species of dove, quail, and desert cottontail rabbits is permitted on designated sites in the refuge. Within the survey corridor, hunting for mule and whitetail deer and collared peccary also occurs.

4.7.2 Wildlife and Habitat Overview

The survey corridor supports diverse populations and individuals of vertebrate wildlife species (see **Attachment C**) and unique-to-common native and nonnative wildlife habitats, described as vegetation alliances, plant associations, or land-use types in this BSR. **Table 4-4** lists wildlife observed during the field surveys that were conducted in early spring (April to May) of 2008. Along the international border, climate, geology, soils, land forms, geography, precipitation, and plant communities combine to provide moderate habitat diversity.

Table 4-4. Wildlife Species Observed Within the Survey Corridor, Staging Areas, and Associated Access Roads

Group / Scientific Name	Common Name	Relative Abundance
BIRDS		
Falco sparverius	American kestrel	Rare
Corvus corax	Common raven	Uncommon
Corvus cryptoleucus	Chihuahuan raven	Common
Geococcyx californianus	Greater roadrunner	Rare

Group / Scientific Name	Common Name	Relative Abundance
Zenaida asiatica	White-winged dove	Rare
Zenaida macroura	Mourning dove	Common
Chordeiles acutipennis	Lesser nighthawk	Uncommon
Buteo jamaicensis	Red-tailed hawk	Uncommon
Buteo nitidus	Gray hawk	Rare
Eremophila alpestris	Horned lark	Uncommon
Callipepla gambelii	Gambel's quail	Common
Fulica americana	American coot	Uncommon
Zonotrichia leucophrys	White-crowned sparrow	Common
Tyrannus verticalis	Western kingbird	Uncommon
Cathartes aura	Turkey vulture	Common
MAMMALS		
Unknown bat	Bat	Rare
Canis latrans	Coyote	Uncommon
Odocoileus hemionus	Mule deer	Uncommon
Lepus californicus	Black-tailed jackrabbit	Common
Sylvilagus audubonii	Desert cottontail	Abundant
REPTILES AND AMPHIBIANS		
Elgaria kingii	Madrean alligator lizard	Uncommon
Heloderma suspectum	Gila monster	Rare
Phrynosoma sp.	Horned lizard	Unknown
Masticophis flagellum	Coachwhip	Common
Pituophis catenifer	Gopher snake	Common
Crotalus atrox	Western diamondback rattlesnake	Common

Within the survey corridor, the broad habitat types available to resident and migrating wildlife species include herbaceous vegetation, shrubland, woodland, and forest. Most of the available wildlife habitat consists of semi-arid desert shrubland communities that have become established on ridges, slopes, alluvial fans and plains, and along arroyos, gullies, and desert washes. This section provides a brief summary of wildlife habitats observed and sampled in 2008 during Environmental Stewardship Plan preparation, categorized as follows:

1. Herbaceous Vegetation: This class of wildlife habitat includes annual and perennial species of grasses, forbs, and graminoids, which typically are characterized by no less than 15 percent cover by shrubs or trees. Stands of herbaceous vegetation range from less than 0.5 m to 2.0 m tall and low to dense in terms of cover. Herbaceous wildlife habitat occurs in small bunchgrass patches on ridges and slopes, small stands on disturbed sites of alluvial plains, and large stands within the cienega bottom.

   a. *Grasslands* – On ridges and slopes of upper elevations, patches of tobosa occur within larger stands of ocotillo, creosotebush, and honey mesquite shrublands. Rock outcrops occasionally supported patches of little bluestem. One heavily grazed alluvial plain site near a livestock corral supported hook threeawn almost exclusively. Desert wash bottoms, particularly the broader ones, often supported stands of alkali and giant sacaton and scattered shrubs of honey mesquite and littleleaf sumac. One irrigated pasture was planted to Bermuda grass. Grassland dominated habitats occur on approximately 9.1 acres within the survey corridor and provide forage, escape cover, and breeding/nesting sites for several species of wildlife. Species common to grassland habitats include desert cottontail, pocket gophers, pocket mice, harvest mice, deer mouse, grasshopper mice, coyote, mule deer, falcons, hawks, turkey vulture, ravens, quail, doves, loggerhead shrike, sparrows, meadowlarks, toads, lizards, and snakes.

   b. *Forblands* – Forbs, including baileya, slimleaf bursage, Russian-thistle, common cocklebur, and annual sunflowers are rare dominants within the survey corridor, becoming established on one disturbed alluvial plain site, in an excavation used for road fill material, and in the large fallow agricultural field that was once part of a cienega bottom. Forb-dominated habitats occur on approximately 6.2 acres within the survey corridor and provide forage, escape cover, and breeding/nesting sites for several species of wildlife. Species common to forbland habitats include desert cottontail, ground squirrels, pocket gophers, pocket mice, harvest mice, deer mouse, grasshopper mice, coyote, collared peccary, mule and whitetail deer, falcons, hawks, turkey vulture, ravens, quail, doves, loggerhead shrike, sparrows, goldfinch, meadowlarks, toads, lizards, and snakes.

   c. *Emergent Wetlands* – Narrowleaf cattail, three-square bulrush, saltgrass, alkali sacaton, and sedges occur on the margins of ponds, seeps, springs, and on the banks of (b) (7)(E) occupying approximately 0.1 acre within the survey corridor. Emergent wetlands can be from 0.5 m to 3 m in height, dense, and along with associated aquatic habitat supporting diverse birds, mammals, reptiles, amphibians, fishes, and many invertebrates. Species common to emergent wetland and associated aquatic habitats include desert shrew, bats, pocket gophers, mice, raccoon, skunks, collared peccary, coyote, whitetail deer, American coot, ring-necked duck, gadwall, Mexican duck, mallard, great blue heron, pied-billed grebe, falcons,

hawks, quail, killdeer, doves, owls, flycatchers, vireos, swallows, wrens, northern mockingbird, warblers, sparrows, blackbirds, toads, leopard frogs, bullfrogs, Sonoran mud turtle, garter snakes, and fishes (minnows, suckers, catfish, topminnows).

2. Shrublands: This habitat class is dominant within the survey corridor, occupying approximately 404.2 acres. The characteristic upland shrubs range from 0.5 m to 5 m tall and include ocotillo, creosotebush, honey mesquite, tarbush, whitethorn, four-wing saltbush, shrubby coldenia, and mortonia. Characteristic shrubs of desert washes, creeks, and draws include honey mesquite, seepwillow, burro bush, and littleleaf sumac. Shrublands provide sparse to dense cover and are common on the ridges and hills of the western Project terminus.

   a. *Dwarf-shrublands* – Dwarf-shrub stands occur on approximately 8.2 acres of exposed hilltop along access roads and bladed sites (b) (7)(E) (b) (7)(E) This habitat is characterized by shrubby coldenia, foure-wing saltbush, honey mesquite, and creosotebush that provided limited wildlife habitat. Common wildlife species likely to use this habitat include desert cottontail, black-tailed jackrabbit, ground squirrels, pocket mice, coyote, mule deer, turkey vulture, ravens, falcons, hawks, quail, doves, loggerhead shrike, sparrows, lizards, and snakes.

   b. *Short Shrublands* – Stands of short shrubs occur throughout the survey corridor on approximately 385.2 acres of gravelly to cobbly ridges, hills, and slopes, on exposed bedrock of ridges, on alluvial fans and plains, and along desert washes and gullies. Short shrub stands are characterized by creosotebush, honey mesquite, whitethorn, tarbush, and mortonia primarily. Stands range from 1 m to 3 m tall and provide low to moderately high foliar cover. Nearly all wildlife species within the survey corridor use the short shrub habitats for forage, escape cover, breeding/nesting, and resting. The most common species include bats, desert cottontail, black-tailed jackrabbit, ground squirrels, pocket mice, deer mouse, other mice, kangaroo rats, coyote, gray fox, badger, bobcat, collared peccary, mule deer, Swainson's hawk, red-tailed hawk, American kestrel, turkey vulture, quail, greater roadrunner, owls, nighthawks, flycatchers, kingbirds, Chihuahuan raven, wrens, thrashers, sparrows, Madrean alligator lizard, collared lizard, horned lizards, colubrid snakes, and western diamondback rattlesnake.

   c. *Tall Shrublands* – Stands of tall shrubs occur on ridges and slopes characterized by ocotillo and on slopes, along desert washes, and on flats characterized by honey mesquite. Tall shrubs typically range from 3 m to 6 m tall, this habitat type ranges from low to dense in terms of foliar cover, and approximately 90.1 acres occur in the survey corridor. Tall shrubs provide important perching, breeding, nesting, brood rearing, and escape cover for a variety of wildlife including bats, desert cottontail, ground squirrels, pocket mice, deer mouse, other mice,

kangaroo rats, coyote, gray fox, badger, bobcat, collared peccary, mule deer, Swainson's hawk, red-tailed hawk, American kestrel, turkey vulture, quail, owls, nighthawks, flycatchers, kingbirds, Chihuahuan raven, warblers, wrens, thrashers, towhees, sparrows, colubrid snakes, and western diamondback rattlesnake.

3. Woodlands and Forests: Open- to closed-canopy stands of trees occupy approximately 19.3 acres of (b) (7)(E) drainage banks and terraces. Fremont cottonwood, Arizona sycamore, and Goodding willow trees have become established as a gallery forest on the banks of (b) (7)(E). (b) (7)(E) supports Fremont cottonwood and honey mesquite trees (b) (7)(E) and honey mesquite trees updrainage. (b) (7)(E) is dominated by honey mesquite trees on an elevated terrace. Other drainages, terraces, and depressions support woodlands dominated by honey mesquite that cover approximately 78 acres. Woodlands typically provide moderate canopy cover and range between 4 m to 10 m tall and forest stands range between 10 m to 35 m tall, provide dense canopy cover, and usually have a subcanopy layer, which enhances the wildlife habitat value in terms of structure.

   a. *Drainage Banks, Floodplain Terraces, and Springs* – The riparian gallery forest and woodland habitats of (b) (7)(E) support moderately open- to close-canopied stands dominated by Fremont cottonwood, Arizona sycamore, and honey mesquite. A moderately well-developed subcanopy in (b) (7)(E) stands provide additional wildlife habitat values. Numerous avifauna use the bank and terrace woodland habitat for foraging, breeding, nesting, brood rearing, perching, and escape cover, including the Swainson's hawk, red-tailed hawk, American kestrel, doves, owls, nighthawks, hummingbirds, Gila woodpecker, northern flicker, flycatchers, kingbirds, vireos, verdin, northern mockingbird, warblers, common yellowthroat, yellow-breasted chat, summer tanager, towhees, sparrows, northern cardinal, pyrrhuloxia, grosbeaks, and Bullock's oriole. Mammal use is high in these mesic habitats with common species and groups including bats, raccoon, desert cottontail, pocket gophers, skunks, mice, coyote, bobcat, collared peccary, and mule and white-tailed deer. Reptiles and amphibians common to the riparian habitats of these drainages include species of toads, lizards, colubrid snakes, and rattlesnakes. Moderate to high diversity of invertebrates occurs within these terrace woodlands and forests.

4. Open Water: Occupying approximately 0.1 acre within the Project area, open water habitats are species-rich in terms of wildlife use and as habituated for threatened and endangered amphibians and fishes. Water bodies occurred as a pond in (b) (7)(E) and a nearby pond supported by a flowing artesian well. Most water sources are ephemeral, flowing

following precipitation events of sufficient size to produce runoff and typically during the monsoon months of July through September. The bottom substrate of water bodies and ephemeral drainages is typically sand and fine sediments.

a. *Creeks, Draws, and Desert Washes* – Flowing water habitat was not present during the early spring survey corridor survey and unvegetated dry washes occurred on approximately 2.8 acres. In addition to many unnamed desert washes, arroyos, and gullies are (b) (7)(E) which are ephemeral and flow primarily during the monsoon season. Because of active seeps and springs, (b) (7)(E) maintains ponded water throughout the year. These open water habitats and their associated riparian and wetland vegetation are extremely valuable to local and seasonal vertebrate and invertebrate wildlife species of the survey corridor.

b. *Lakes and Ponds* – Ponds occur within (b) (7)(E) on the alignment and where artesian wells discharge north of the alignment (b) (7)(E) (b) (7)(E). The wetland and riparian vegetation surrounding the shoreline and the size of the water body can dictate the species using still open water, which include the American coot, a variety of ducks, passerine birds, Sonoran mud turtle, leopard frogs, bullfrogs, Mexican and checkered garter snakes, endangered and threatened fishes, and insects.

5. Land Use: Small acreages in the survey corridor are maintained on a regular basis, ranging from monthly to yearly maintenance of (b) (7)(E) (b) (7)(E) to less periodic maintenance on secondary access roads and trails. Even though subject to disturbance, these habitats are somewhat important to many species of resident and migratory wildlife which use them as movement corridors, foraging sites, and sunning sites.

    a. *Irrigated Agriculture* – One small irrigated pasture of Bermuda grass occurs on approximately 0.3 acre in the survey corridor. It is grazed by horses and mules but also provides habitat for local wildlife that forage and seek water in this nonnative shortgrass habitat.

    b. *Fallow or Go-Back Agriculture* – (b) (7)(E) Approximately 2.2 acres of this habitat support a large number of perennial grasses and annual forbs which range to 3 m tall and provide quantities of seed used by foraging wildlife. Seeds present on the go-back fields attract mule deer, desert cottontail rabbit, other small mammals, species of sparrows, and species of doves. Raptors and other predators regularly forage over or in this habitat.

    c. *Highways, Roads, and Trails* – Wildlife species use established transportation corridors to move and disperse rapidly across the

landscape. As a result, low to moderately high death rates can be experienced depending on adjacent habitat importance to wildlife, population levels, and design speed and safety features of transportation corridors. The western diamondback rattlesnake and other snake species were observed sunning on (b) (7)(E) in the survey corridor. Wildlife that forage on carrion or are omnivorous, including the turkey vulture, other raptors, and coyote, can benefit from the presence of road-killed animals. Transportation structures such as bridges can provide hiding and roosting cover for species including owls and bats or nesting sites for swallows. Approximately 47.1 acres of this land use type occur in the survey corridor.

4.8 Species Groups and Habitat Affinity

4.8.1 Mammals

Fifty-five species of mammals have been recorded (b) (7)(E) habitats and also use adjacent landscapes of the survey corridor (see **Attachment C**). The largest species groups include bats (14) and mice, including pocket mice (10). Most of the mammals are nocturnal (night-active) or crepuscular (dusk- and dawn-active), and with the exception of the bat species are year-round residents. Black bear may traverse the survey corridor in search of forage. The rugged mountains that surround the (b) (7)(E) may support the very rare and federally endangered jaguar and ocelot, which have been recorded southeast and west of the area.

4.8.2 Birds

(b) (7)(E) the survey corridor support at least 268 bird species (see **Attachment C**) (USFWS 2008). Raptors that commonly use area habitats include American kestrel, peregrine falcon, red-tailed hawk, sharp-shinned hawk, Swainson's hawk, gray hawk, zone-tailed hawk, golden eagle, turkey vulture, and Chihuahuan raven (USFWS 2008). Aquatic birds and and shorebirds that have been observed in the refuge include American coot, great blue heron, green-backed heron, Virginia rail, ringneck duck, Mexican duck, and sandhill crane. Other species and groups of birds common to the survey corridor include doves, greater roadrunner, owls, nighthawks, hummingbirds, flycatchers, loggerhead shrike, vireos, swallows, verdin, wrens, northern mockingbird, thrashers, warblers, tanagers, towhees, sparrows, grosbeaks, eastern meadowlark, and Bullock's oriole.

Large numbers of birds migrate seasonally through the (b) (7)(E) using the natural and managed habitats for forage, roosting, and cover. The drainages and linear mountain ranges can serve as leading lines to guide raptors and neotropical migrants during migration.

The establishment of the (b) (7)(E) in addition to other Federal, state, and private lands is important to migratory bird management. The primary function of lands managed under the National Wildlife Refuge System is to provide habitat for waterfowl and shorebirds in addition to other wildlife-related benefits. A focused list for species occurring in the survey corridor is presented in **Attachment C**.

The American peregrine falcon, a subspecies of the peregrine falcon, currently proposed for de-listing, is reported as a rare migratory visitor to the Project area (USFWS 1995). Under the *Peregrine Falcon Recovery Plan* the general goal is to restore a self-sustaining population of peregrine falcons in the western United States. The (b) (7)(E)(b) (7)(E) and private landowners contribute towards restoration goals by conserving wintering and migratory habitats, protecting peregrine falcons through law enforcement efforts, and promoting public support and understanding through education.

The bald eagle has been de-listed from federally endangered to the threatened status throughout the United States except in the Sonoran Desert. Bald eagles are still protected by the Bald Eagle Proteciton Act. The *Bald Eagle Recovery Plan* efforts are undertaken to recover the species and in the Project region are considered significant efforts (USFWS 1995). The (b) (7)(E) , and private landowners contribute towards restoration goals by ensuring that bald eagle habitats are protected and possibly enhanced. The refuge protects bald eagles through law enforcement efforts and promoting public support and understanding through education.

The northern aplamado falcon was a former resident of desert grasslands of southeastern Arizona that has been extirpated from the United States and contaminated by pesticides in Mexico (USFWS 1995). The *Aplomado Falcon Recovery Plan* included six objectives: (1) evaluate, monitor, and minimize all threats, including pesticides, to extant populations; (2) identify, maintain, and improve habitat; (3) re-establish the northern aplomado falcon in the United States and Mexico; (4) conduct studies of habitat requirements, physiological ecology, and behavior; (5) enhance public support for this recovery effort through educational programs; and (6) encourage national and international cooperation and coordination in carrying out these objectives. (b) (7)(E)was considered a possible re-introduction site for the northern aplomado falcon but further restoration of native grasslands and riparian woodlands/forests would be required. Northern aplomado falcons were planned to be released in Chihuahuan desert grassland habitats of southwestern New Mexico and were expected to spread into southeastern Arizona if releases were successful (Federal Register 2006, USFWS 2006). The goal of re-introduction would be to maintain a self-sustaining resident population of 60 breeding pairs between the years 2010 to 2030.

4.8.3 Reptiles and Amphibians

A species list of 39 reptiles and amphibians was compiled (b) (7)(E) (see **Attachment C**). During early spring wildlife surveys of the survey corridor, western diamondback rattlesnakes, coachwhips, the Gila monster, and lizard species were observed. Other reptile and amphibian species that could occur include the black-tailed rattlesnake, desert kingsnake, ringneck snake, Madrean alligator lizard, collared lizard, and horned toad in uplands and rock outcrops, while the wetland habitats support the Chiricahua leopard frog, Sonoran mud turtle, and checkered and Mexican garter snakes (USFWS 2008).

The federally threatened Chiricahua leopard frog population continues to decline due to habitat degradation, predation by nonnative bullfrogs and other wildlife species, and exposure to a lethal skin fungus (USFWS 2008). Management and protection of this rare leopard frog species in the Project area include efforts by the USFWS, AZGFD, University of Arizona, (b) (7)(E) High School, and private landowners.

The rare Mexican garter snake is one of three species of garter snake that inhabit riparian and wetland habitat in the survey corridor. The population on (b) (7)(E) has been reduced by predation by the nonnative bullfrog, which forages on young snakes. Restoration of densely vegetated cienega wetland habitats on (b) (7)(E) and the (b) (7)(E) assist with the recovery of the Mexican garter snake.

4.8.4 Fish

(b) (7)(E) is one of the few units within the refuge system created specifically to protect native fish; there are eight fish species (b) (7)(E) see **Attachment C**). (b) (7)(E) ff is focused on preserving the remaining fisheries habitat, restoring degraded habitats, and maintaining native fish populations in appropriate habitats. In addition to physical effects due to construction, (b) (7)(E) and construction staging could result in sedimentation into the refuge drainages. Soils of the former cienega are extremely fine silt and clay and are highly erodible both by water and wind action. The preferred crossing of (b) (7)(E) from a fisheries perspective would be a concrete low water crossing with a perpendicular downstream face high enough to impede fish from downstream from entering the refuge (Radke pers. comm. 2008).

Prior to drainage of wetlands and loss of permanent surface flows, (b) (7)(E) drainages and cienega supported approximately one-fourth of the fish species native to Arizona (USFWS 2008). The more common species were Mexican stoneroller, longfin dace, roundtail chub, and Yaqui sucker. Endangered and threatened fish species that occurred historically through present include the Yaqui chub, Yaqui topminnow, beautiful shiner, and Yaqui catfish.

The federally threatened beautiful shiner was eliminated from the United States by 1970 due to the loss of suitable wetland and aquatic habitat (USFWS 2008).

The current populations (b) (7)(E) were reintroduced from stock captured in the Sierra Madre of Mexico. The federally endangered Yaqui chub is confined to the upper Rio Yaqui Basin (b) (7)(E) and populations occur in (b) (7)(E) Arizona, and (b) (7)(E) in Mexico. Most of the populations are threatened due to infestations of nonnative Asian tapeworms which are parasites of the digestive system. The federally threatened Yaqui catfish was eliminated from U.S. waters and reestablished with Mexican stocks in 1996. The species now occurs in (b) (7)(E) Arizona. The federally endangered Yaqui topminnow was severely affected by the loss of wetland and aquatic habitat by vegetation encroachment and by the introduction of nonnative mosquitofish. It now occurs in (b) (7)(E), and in Mexico (b) (7)(E).

The *Fishes of the Rio Yaqui Recovery Plan* (USFWS 1994a) outlined the objectives required to recover the Yaqui chub, Yaqui topminnow, Yaqui catfish, and beautiful shiner as secure and stable elements of the native fish fauna of the river system where they once occurred. A combination of refuge protection strategies and habitat protection in Mexico is necessary for these rare fishes to be down-listed. There must be compliance with the following conditions for a period of five years before down-listing of the federally endangered Yaqui chub and Yaqui topminnow to federally threatened status can be considered: (1) all nonnative fish species must be eradicated from critical habitat; (2) secure and protect the San Bernardino aquifer so that all artesian flows maintain themselves year-round, secure and protect Leslie Creek watershed to ensure adequate flows for Leslie Creek; and (3) protect critical habitat from detrimental human disturbance including mining, introduction of nonnative fishes, water diversion, and removal.

4.8.5 Invertebrates

Southeastern Arizona has been described as an ecological crossroads due to intersecting geographies including the Chihuahuan and Sonoran deserts and southern Rocky Mountains and Sierra Madres. As a result, invertebrates are diverse, e.g., over 100 butterfly species occur in (b) (7)(E) and adjacent survey corridor support an abundance of butterflies, damselflies, and other invertebrates, including several unique tropical species. Some species of invertebrates have been documented in the United States only within the refuge (USFWS 2008).

The (b) (7)(E) springsnail occurs within a single small spring on (b) (7)(E) r (b) (7)(E) and at two locations (b) (7)(E) in Mexico. Research is currently being conducted to determine the species habitat requirements or its tolerances.

4.9 Prehistoric Humans, Spanish Settlement, and Current Land Conservation

This section briefly summarizes human use of the survey corridor. Generally, the survey corridor uplands were used sparingly by prehistoric humans and historically for grazing livestock and farming. However, the (b) (7)(E) (b) (7)(E) with several permanent water sources, has attracted humans both prehistorically and historically resulting in the basis for much of the discussion herein. Forms of farming within the valley occurred over the past 800 years, reaching an apex and level of disturbance to the natural landscape between about 1900 to 1979 (USFWS 1995).

The upper Rio Yaqui watershed has supported humans since prehistoric times, with evidence of use dating over 10,000 years ago to the Clovis culture (USFWS 1994a). The principal prehistoric periods represented in the survey corridor were the late Archaic (approximately 1500 BC–500 BC) and the late prehistoric pueblo occupation (approximately AD 1200–AD 1400) (USFWS 1995).

Archaic humans practiced a hunting-gathering lifestyle throughout the desert southwest; in the Project area artifacts included projectile points (Pinto, Chiricahua, and San Pedro styles), ground stone artifacts, hearths, and roasting pits with the absence of ceramics (USFWS 1995). (b) (7)(E) supported a large semipermanent campsite during the Archaic Period.

Pueblo-dwelling humans that occupied permanent settlements and practiced agriculture settled in the Project area from approximately 600 to 800 years ago (USFWS 1995). This occupation has been named by various researchers as the Animas Phase, Casas Grandes, or Salado cultures, people who possessed architectural and material cultures with strong ties to similar advanced societies in Chihuahua. The largest pueblo period site or pit house village in the Project area is located on the historic (b) (7)(E); it consisted of approximately 100 rooms and one or more plazas located on a bench above (b) (7)(E) and (b) (7)(E) (USFWS 1995).

In approximately the early 1600s, the Apache Tribe frequented the Project region to hunt, gather food, and conduct raids (USFWS 2008). They frequented this region until 1886 when Geronimo and his forces surrendered in (b) (7)(E) (b) (7)(E).

The Coronado-led Spanish expedition passed near the survey corridor in search of the Seven Cities of Cibola during 1540 (USFWS 2008). European presence in the survey corridor dates to around 1694 when Jesuit Padre Eusabio Francisco Kino (an Italian priest) and Captain Juan Mateo Manje traveled through the (b) (7)(E) (Lanning 1981, NPS 2008). At that time there was an Opata Indian village on the location of the (b) (7)(E).

Padre Kino established good relations with the indigenous Piman groups and assisted them in resisting the Apache tribes. He was also credited with introducing agriculture and animal husbandry including wheat and domestic livestock, particularly cattle and sheep. Jesuit priests established a mission in the (b) (7)(E) during the 1700s and a Spanish Presidio was established there in 1774 (USFWS 2008).

Feral livestock were abundant by 1822, when the 73,000-acre (b) (7)(E), created by decree of the Spanish Crown, was acquired by Lieutenant Ignacio de Perez (USFWS 1994). Large-scale cattle, mule, and horse grazing occurred for ten years (up to 100,000 head), until 1832, when Perez was driven from the valley by the Apache Tribe (USFWS 2008). This land grant included much of the survey corridor.

In 1846, the Mormon Battalion under Lieutenant Colonel Philip St. George Cooke passed through the (b) (7)(E) enroute to California. They encountered many wild cattle and one of the battalion noted that the grass was two feet high as far as the eye could see and there was plenty of water, but there was no wood barring mesquite (USFWS 1993). (b) (7)(E) near the entrance to the (b) (7)(E)

In 1853, the Gadsden Purchase placed the international boundary such that 2,383 acres of the original land grant/ranch lay within the United States and the remainder in Mexico. A total of 65,000 acres of the land grant were purchased by "Texas" John Slaughter (John Horton Slaughter, a Texas cattle rancher) in 1884 and was used to raise longhorn cattle (up to 50,000 head) and for farming (hay, barley, wheat, and vegetables) until 1937 (USFWS 1994). The center of a cattle ranching empire that straddled the U.S.-Mexico border, this ranch illustrated the continuity of Spanish and American cattle ranching in the Southwest. Until late in the nineteenth century, the (b) (7)(E), a well-watered area occupying southern Arizona and northern Mexico, was not successfully occupied by Europeans due to the threat of Apache attack; in 1884, however, Slaughter leased a portion of the Mexican land grant and began the development of a ranch that would span up to 100,000 acres, supplying beef, fruits, and vegetables to the surrounding settlements and military posts.

In 1915, the Mexican Revolution included this area of the border and General Pancho Villa and his troops fought in nearby Agua Prieta (USFWS 2008). Between 1914 to 1919, U.S. cavalry encampments were established in the valley to protect settlers from raids conducted by General Villa. U.S. troops were stationed at the (b) (7)(E) during this period and remnants of the rock fortifications remain on the (b) (7)(E)

Between 1937 and 1979, there were a number of owners who conducted cattle ranching and farming in the valley, until the (b) (7)(E) was purchased by The Nature Conservancy, transferred to the USFWS in 1982, and established as the (b) (7)(E) (USFWS 1994). Properties adjacent to the refuge and composing

the remainder of the survey corridor are primarily privately owned ranch lands and lands managed by the State of Arizona (USFWS 1995).

Farming, mineral extraction, fire control, and livestock production altered and eliminated much of the natural wildlife habitat in the Rio Yaqui Basin over the past 100-plus years (USFWS 2008). Some wetlands were drained to increase cropland acreage and streams were diverted to irrigate fields and fill water impoundments. Grasslands were diminished by unsustainable grazing practices and many surface water flows were eliminated. The very large (b) (7)(E) (b) (7)(E) (described as marshy and spring-fed) once persisted on both sides of the international border, but has been reduced to isolated artesian wells and artificial ponds and it supports old field vegetation. Stands of honey mesquite trees and shrubs have become established across the former cienega.

4.10 Habitat Restoration and monitoring

Extensive habitat restoration has been undertaken on the (b) (7)(E) and on adjacent private lands (USFWS 2008). Eroded and incised stream channels are being elevated and armored using wire-basket gabions filled with rocks and by planting Fremont cottonwood and Goodding willow trees. Upland habitats are being replanted to native grass species and old farm fields are being returned to former cienega wetland conditions. Invasive, nonnative species are being controlled or removed from the habitats. Controlled fires are being used to burn the litter from native grasses, to return nutrients to the soil, and to control the spread of honey mesquite trees and shrubs across the former cienega.

Cooperative conservation between U.S. government and environmentally sensitive landowners in Mexico and the United States is protecting additional habitat and water sources, providing additional scientific research, and allowing introductions and maintenance of fish and wildlife populations. Restored wetlands support waterfowl, riparian gallery forests support raptors and migrating passerine bird species, and measures are being enacted to reduce erosion, protect groundwater levels, and to reclaim honey mesquite-dominated lowlands. Monitoring is being designed and conducted to record the results of management actions, guide future management decisions, and to learn more about the complex ecological relationships.

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BIOLOGICAL SURVEY
ATTACHMENT A

DESCRIPTION OF FEDERALLY LISTED SPECIES

Beautiful Shiner (*Cyprinella formosa*)

The beautiful shiner was designated as a federally Threatened species on August 31, 1984.

Historic range: Northern Mexico (Sonora, Chihuahua), southeastern Arizona (b) (7)(E) Creek and associated artesian wells and cienegas; extirpated by 1970), and southwestern New Mexico (Mimbres River; disappeared after 1951). Current range in Mexico: Guzman basin (including Rios Casas Grandes, Santa Maria, and del Carmen), and Yaqui, Bavicora, and Sauz basins (current status in Sauz Basin is unknown). Elevations in Mexico from 800-1700 m (2625-5580 ft), previously in Arizona at approximately 1,158 m (3,800 ft) (Arizona Game and Fish Department 1994). Reintroduced and thriving on the (b) (7)(E) , Arizona (USFWS 1994). Stocks occur also at the Dexter National Fish Hatchery & Technology Center, Dexter, New Mexico. See USFWS (1994).

Basic Description: A 3-inch fish.

Reproduction Comments: Spawns probably in late spring.

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Moderate gradient, Pool, Riffle, SPRING/SPRING BROOK

Lacustrine Habitat(s): Shallow water

Special Habitat Factors: Benthic

Habitat Comments: A mid-water-column species; remains near but rarely within beds of plants or other cover along pond margins (USFWS 1994). Occupies riffles in small streams or pools of creeks with riffles during high water; also in large streams in rapids and in small tanks and spring-fed ditches. Streams typically are intermittent and subject to seasonal drying and sudden flooding; survives dry periods in permanent pools. Uncommon in large rivers. Small turbid pools over sand, gravel, or boulder substrates (Miller and Simon 1943). Thriving in pond habitats on the (b) (7)(E) in Arizona (USFWS 1994). Eggs are laid in a nest scooped out of gravel by male in shallow, fast-flowing water.

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Feeds mostly on terrestrial and aquatic insects; also eats algae and other plant matter.

Length: 7 centimeters

Management Requirements: Securing habitat and water sources is a major management need (USFWS 1994).

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Desert Pupfish (*Cyprinodon macularius macularius*)

The desert pupfish was designated as a federally Endangered species on March 31, 1986.

Historic Range: Formerly in lower Colorado and Gila river drainages, southern Arizona to southeastern California, and in the Salton Sea and Laguna Salada basins, California and Mexico. Currently occurs in California in San Felipe Creek (lower reaches and associated wetlands; best non-native habitat in California) and San Sebastian Marsh (Imperial County) and Salt Creek (Riverside County; population there may not be viable); also in shoreline pools and irrigation drains in the Salton Sea area, where the species is scarce (Miller and Fuiman 1987). No native populations of *C. macularius* remain in Arizona (Minckley et al. 1991), but several reintroduced populations exist, and the species has been introduced in areas outside the native range. See Hendrickson and Varela (1989) for information on the status of several introduced populations in Arizona. Currently occurs in Sonora, Mexico, in Santa Clara Slough and several locations extending southeast from there, and in northeastern Baja California (notable is an apparently large population found at Cerro Prieto, Baja California) (Hendrickson and Varela 1989, Echelle et al. 2000). Several populations exist in artificial refugia.

Basic Description: A small chunky fish.

Reproduction Comments: Spawning: spring and summer, or year-round in warm constant temperature environments. Each female may lay 50-800 eggs or more/season, depending on her size (Moyle 1976). Males defend eggs. Eggs hatch in 10 days at 20 C (within about 3 days according to Matthews and Moseley 1990). Reproduces at age 2-3 months in constant warm temperatures; first breeds at about 1 year in variable temperatures. Up to 2-3 generations per year (Matthews and Moseley 1990).

Ecology Comments: Typically swims in loose schools, often in groups of similar size and age (Moyle 1976).

Habitat Type: Freshwater

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Low gradient, MEDIUM RIVER, Pool, SPRING/SPRING BROOK

Lacustrine Habitat(s): Shallow water

Palustrine Habitat(s): HERBACEOUS WETLAND

Habitat Comments: Desert springs and outflow marshes, river-edge marshes, backwaters, saline pools, and streams. Original habitat probably was marshes and flood plain pools along the lower Colorado River and springs throughout the Salton Sink. Prefers areas with sand/silt substrates and aquatic plant life, limited surface flow, water less than 1 m in depth. Tolerates low oxygen levels, high temperatures, and high salinity. May forage in shallows in early morning, deeper water most of day. Often rests on bottom, especially at night. May dive into anoxic bottom mud. Male establishes territory prior to spawning, usually in water less than 1 meter deep (sometimes deeper). Territory is typically 1 to 2 square meters or more (Moyle 1976). Eggs are laid on substrate of sand, mud, or perhaps preferentially on algal mat (Schoenherr 1988).

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Opportunistic. Feeds on algae, detritus, and small invertebrates. In the Salton Sea eats ostracods, copepods, and some insects and pile worms. In other areas feeds on aquatic crustaceans, aquatic insect larvae, and molluscs (Moyle 1976).

Phenology Comments: May burrow into loose substrate and become dormant in winter when temperatures are extreme.

Length: 6 cm

Management Requirements: Introductions into marginal, semi-natural, relatively stable habitats have not been especially successful; recovery planners should consider use of riverine habitat and manipulations of flows or other disturbances (Hendrickson and Varela 1989). See Meffe and Vrijenhoek (1988) for a discussion of conservation genetics.

Monitoring Requirements: San Felipe Creek and Salt Creek populations are regularly monitored by California Dept. of Fish and Game (California Department of Fish and Game 1990).

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Gila Chub (*Gila intermedia*)

The Gila chub was designated as a federally Endangered species on August 9, 2002.

Historic Range: Historically occurred in springs and small streams in the upper Gila River basin in southern Arizona, southwestern New Mexico, and northeastern Sonora, Mexico (Miller and Lowe 1964, Minckley 1973, USFWS 2002). In Arizona, Gila chub are known to have occupied portions of the Salt, Verde, Santa Cruz, San Pedro, San Carlos, San Simon, San Francisco, and Agua Fria drainages and smaller tributaries of the mainstem Gila River. Small remnant populations remain in most of these drainages with the exception of the Salt and San Simon Rivers, where all known populations have been extirpated. An observation of a Gila chub in Turkey Creek in the upper Gila River Basin in New Mexico was made in 2001 (Telles, pers. comm., 2001, cited by USFWS 2002). The current known distribution of Gila chub in Mexico has been reduced to two small spring areas, Cienega los Fresnos and Cienega la Cienegita, adjacent to the Arroyo los Fresnos (tributary of the San Pedro River), within 2 km (1.2 mi) of the Arizona-Mexico border (Varela-Romero et al. 1992). No Gila chubs remain in the Mexican portion of the Santa Cruz River basin (Weedman et al. 1996).

Basic Description: A fish (chub) that typically is about 15 cm long.

General Description: Fishes of the genus *Gila* that occur in the Colorado River basin range from the streamlined *Gila elegans* of large rivers, through *G. robusta* of intermediate-sized rivers, to the thick-bodied *G. intermedia* of creeks and marshes (cienegas) (Minckley 1973, DeMarais 1986). The following description of Gila chub is mainly from Minckley (1969, 1973) and Rinne (1976). The Gila chub is a robust, darkly colored minnow. A typical Gila chub would be approximately 150 mm in length. Gila chub from Redfield Canyon ranged in size from 45-222 mm TL (n=113) (Griffith and Tiersch 1989). At ages 1-4 years, based on scale analysis, calculated lengths averaged 90, 135, 160, and 183 mm TL. Minckley (1969) reported that males are typically smaller than females. Gila chubs usually have eight dorsal, anal, and pelvic fin rays. Scales are large and number less than 80 and more than 61 in the lateral line. Scales are also thick and broadly imbricate, and basal radii are usually present. Vertebrae number from 38 to 45. Barbels are absent and pharyngeal teeth are in two rows (2,5-4,2 with some variation). Head length divided by caudal peduncle depth is 3.0 or less. Both sexes possess breeding tubercles, although their distribution is less extensive on females. Minckley (1969) gave the following description of breeding coloration: "Breeding coloration in this fish may be far more intense than in other forms of the genus in Arizona. The axial and inguinal regions become a deep orange-red, which may develop further into a broken, orange-red band along the lower sides and caudal peduncle, extending forward to include the brancheostegal rays and cheeks. The eyes of males become yellow to yellow-orange and the body is blue-black dorsally. Fins of some individuals, especially the larger ones, may be washed with lemon yellow." Larvae were described by Winn and Miller (1954).

Diagnostic Characteristics: The Gila chub is most similar morphologically to the roundtail chub. The latter usually is lighter colored, less robust, and with scales that are relatively smaller, thinner, and only slightly embedded; basal radii on scales are absent to weakly developed; the number of dorsal, anal and pelvic fin rays in roundtail chubs usually is nine; there are usually 81 or more scales in the lateral line and 43 to 49 total vertebrae; the length of the head divided by the depth of the caudal peduncle is typically 3.3 to 4.3, rarely greater than 4.0. The Yaqui chub, *Gila purpurea*, and the Sonora chub, *Gila ditaenia*, have radii strongly developed on all fields of scales, the mouth is horizontal to oblique, and a basicaudal spot is present albeit possibly discrete or diffuse. *Gila elegans* is distinctive as adults and may be distinguished from the Gila chub using characteristics described by Douglas et al. (1989). *Gila elegans* has been extirpated from areas where the Gila chub occurs and, unless reintroductions of these species occur, these three species will not be taken in the same collections.

Reproduction Comments: In Monkey Spring, a relatively-constant spring-fed pond, reproduction may have last throughout late winter, spring, and summer, and perhaps into autumn (Minckley 1969, 1985). In other areas it occurs mostly in late spring and summer (Minckley 1973). Most Gila chub probably mature in their second or third year of life (Griffith and Tiersch 1989).

Ecology Comments: The Gila chub is associated with a native fish fauna that includes loach minnow (*Tiaroga cobitis*), spikedace (*Meda fulgida*), speckled dace (*Rhinichthys osculus*), longfin dace (*Agosia chrysogaster*), Sonora sucker (*Catostomus insignis*) and desert sucker (*Pantosteus clarki*). Historically, it also was associated with the woundfin (*Plagopterus argentissimus*), bonytail (*Gila elegans*), squawfish (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and Gila topminnow (*Poeciliopsis occidentalis*), all of which are now extirpated from the Gila River basin. Gila chub and roundtail chub are sometimes found in the same stream systems, separated by only tens of meters; however, the two species have never been collected together at the same site (DeMarais 1990; Minckley 1985, 1990).

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, MEDIUM RIVER, Moderate gradient, Pool, Riffle, SPRING/SPRING BROOK

Palustrine Habitat(s): HERBACEOUS WETLAND

Habitat Comments: Gila chubs commonly inhabit pools in smaller streams, springs, and cienegas, and they can survive in small artificial impoundments (Miller 1946, Minckley 1973, Rinne 1975). They are highly secretive, preferring quiet, deeper waters, especially pools, or remaining near cover including terrestrial vegetation, boulders, and fallen logs (Minckley 1973, Rinne and Minckley 1991). Minckley (1973) suggested that spawning may occur over beds of aquatic plants. Specific habitat associations are known to vary ontogenetically and likely vary seasonally and geographically. Young in Monkey Spring, Arizona (from which the species is now extirpated), 25-75 mm total length (TL), were found in swifter areas than were adults, which utilized undercut banks and heavily vegetated margins of the spring run (Minckley 1969). Griffith and Tiersch (1989) collected Gila chubs from both riffles and pools in Redfield Canyon, Arizona.

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Feeds mainly on aquatic and terrestrial insects and filamentous and diatomaceous algae (Minckley 1973, Griffith and Tiersch 1989). Of 27 specimens examined for stomach contents in Redfield Canyon, four contained remains of fishes; three contained *Rhinichthys osculus* (Griffith and Tiersch 1989). Gila chubs were observed chasing Gila topminnows in Monkey Spring (Minckley 1969). No information is available on dietary differences between size or age classes. Larger individuals feed during evening and early morning hours, whereas young chubs feed during all daylight hours (Minckley 1973, Griffith and Tiersch 1989).

Phenology Comments: Young are active throughout the day; larger individuals tend to be most active in evening and early morning.

Stewardship Overview: Existing Gila chub populations need to be identified and carefully monitored. Protection would be enhanced by the elimination of detrimental water and land use practices and the removal of non-native fishes. Degraded habitats should be reclaimed and enhanced, and chubs should be reintroduced where chances for success are judged good. Research is needed to identify specific threats.

Restoration Potential: Lack of knowledge of the biology of Gila chub clearly is a deterrent to its recovery. Recovery potential is good only if critical habitat is vigorously protected. Remaining populations continue to be threatened by habitat modification and interactions with non-native fishes. Reestablishment in former range is problematic until the causes of the decline are corrected.

Preserve Selection & Design Considerations: Habitat in the form of headwater cienegas or spring-fed streams are critical for the continued existence of the Gila chub. Gila chub also does well in spring-fed ponds if non-native fish are excluded (Minckley 1969).

Management Requirements: Existing populations not infected by non-native fishes should be protected through the establishment of fish barriers if such is judged not to be detrimental to the Gila chub. Necessary habitat and landscape improvements (including removal of non-native fishes) need to be determined and implemented. Stream flows and temperatures should not be modified by activities such as damming or diversion that substantially alter natural regimes. State or other fish management agencies and private entities should discontinue stockings of non-native, warmwater sport, forage, or bait fishes into streams occupied by Gila chub; this protection should extend downstream at least to the first absolute barrier to upstream fish movement. Proper management and maintenance of riparian zones are essential to native fish populations. Changes in the riparian zone can affect leaf fall and energy flow, stream flow, natural cover, temperature, and deposition of eroded materials (Baltz and Moyle 1984). Of five riparian systems studied in Arizona, only Aravaipa Creek, where cattle have been excluded since 1973, showed successful reproduction and dominance of the broadleaf riparian community (Rucks 1984). Cattle-browsing is a major factor in the replacement of a broadleaf riparian community by a riparian scrub community (Rucks 1984). A change from a broadleaf to scrub riparian community can change energy flow, tree-fall cover and amount of shade, and temperature profiles of a stream. Fire would be a preferred method of watershed management when necessary. However, the choice of fire as a management tool must take into account the fuel levels present. A crown fire ("hot fire") can lead to increased runoff and result in the filling of riffle or other spawning areas. The effects of a crown fire and subsequent runoff were reversed in three years in the upper Carmel River, California (Hecht 1984). If watershed management is necessary, controlled burns, frequent enough to prevent build-up of high fuel levels, set during nonspawning periods or periods of decreased spawning activity (winter), should be employed. Populations should be reintroduced into selected streams within the historic range. Potential dispersal routes should be closed to preclude reinvasion of non-native fishes. Barrier design should not significantly alter stream flow and the potential impact on natural upstream and downstream movements of native fishes should be assessed. Habitat improvement should be implemented, which may include removal of non-native fishes by piscicide. Reintroduced stocks should have a genetic affinity with those formerly occupying target streams. Stockings should be done according to guidelines set up by the American Fisheries Society (Williams et al. 1988), consultants familiar with GILA taxonomy, and the U.S. Fish and Wildlife Service. Reintroduced populations should be monitored for success or failure. Populations that are rapidly declining should be secured in a hatchery facility such as the Dexter National Fish Hatchery, Dexter, New Mexico. Techniques for spawning and rearing *Gila* spp. are available (Hamman 1981, 1982, 1982, Muth et al. 1985).

Monitoring Requirements: Known populations should be monitored biannually in the spring during the breeding season and in late autumn to check recruitment. Standardized techniques should be adopted so that data will be comparable over locations and time. Data are needed to distinguish between natural fluctuations in abundance and population decline due to human-

caused perturbation. Monitoring locations for Gila chub should be chosen so that all drainages and morphological variants represented. Techniques available for determination of absolute abundance for fishes are depletion sampling, mark-and-recapture, underwater censusing, and passive capture devices. These may be modified or others developed specifically for application to the Gila chub. Such techniques should be adjusted as dictated by experience, and uniformly applied. *Gila* species can be difficult to collect as they will flee when approached. They are often located under or next to objects, making seining difficult; as a result, electroshocking devices may provide more efficient sampling. Large areas must be sampled to determine presence/absence of Gila chub because certain areas are used, sometimes consistently over time, and others, which may be similar, are not (Minckley 1990). If resources are limited, a better strategy is to sample an entire headspring-cienega-stream system thoroughly every two to three years rather than sampling annually small areas of a stream or cienega system. DeMarais (1990) and Minckley (1990) stated that Gila chub occurrences are extremely spotty and localized. When chub populations are located, these data could be recorded on aerial photographs, and these photographs used to relocate chub populations. Recording these data on aerial photographs might also reveal clues about other stream reaches that have appropriate Gila chub habitat.

Biological Research Needs: The impact of flooding on nutrient cycling, substrate renewal, and availability of cover, with respect to native fishes, needs to be examined.

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Yaqui Chub (*Gila purpurea*)

The Yaqui chub was designated as a federally Enangered species on August 31, 1984.

Historic range: Historically the Yaqui chub occurred in the Rio Yaqui drainage in (b) (7)(E) County, extreme southeastern Arizona, USA, and in a short perennial reach of the (b) (7)(E) (b) (7)(E) (b) (7)(E)) just south of the U.S./Mexico border in Sonora, Mexico. Current distribution in Mexico is unknown. The species was nearly extirpated in the United States, persisting only in one artesian well in (b) (7)(E) Creek drainage (McNatt 1974). It was introduced and established in (b) (7)(E) Creek, Swisshelm Mountains, Arizona, in 1969 (Minckley 1973). Records from Morse Canyon, northern Chiracahua Mountains, Arizona, are not supported by specimens (Willcox Playa basin; McNatt 1974). In the United States, populations are limited primarily to several sites in the (b) (7)(E) and (b) (7)(E) (b) (7)(E) , (b) (7)(E) County, Arizona. Populations from the drainages of the Rio Sonora, Rio Matape, and portions of the Rio Yaqui in Sonora, Mexico, formerly were included in *G. purpurea*; they were described as a new species (*Gila eremica*) by DeMarais (1991).

Basic Description: A fish less than six inches long.

Reproduction Comments: Spawning occurs throughout the warmer months, with greater activity in spring; matures often within the first summer; high reproductive potential (USFWS 1994).

Ecology Comments: Large populations develop quickly from a few adults.

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Moderate gradient, Pool

Habitat Comments: Habitat includes deep pools in creeks, springheads, scoured areas of cienegas, and other stream-associated quiet waters (USFWS 1994); this fish seeks shade, often near undercut banks or debris; it is often associated with higher aquatic plants (Lee et al. 1980). Similarly, in artificial ponds, adults tend to occupy the lower part of the water column and seek shade (USFWS 1994). Young occupy near-shore zones, often near the lower ends of riffles (USFWS 1994). Spawning occurs probably in deep pools where there is aquatic vegetation (Matthews and Moseley 1990).

Adult Food Habits: Herbivore, Invertivore, Piscivore

Immature Food Habits: Herbivore, Invertivore, Piscivore

Food Comments: Eats algae, terrestrial insects, and arachnids. Aquatic insects and small fishes (Poeciliopsis) are eaten when available; also detritus (Matthews and Moseley 1990).

Stewardship Overview: Actions needed (USFWS 1994): 1) Develop co-operative effort with Mexico for the recovery of Yaqui fishes; 2) Secure habitat and water sources for the Yaqui fishes in the USA and Mexico; 3) Conduct research on the biology and habitat requirements of Yaqui fishes; 4) Manage the fish and their essential habitats; 5) Introduce and maintain self-sustaining populations within their historic range; and 6) Monitor existing and established populations and habitats. Management needs: protect (b) (7)(E) aquifers, and (b) (7)(E)

watersheds, to ensure adequate perennial flow; ameliorate effects of non-native fishes within chub management streams; establish and maintain self-sustaining populations on (b) (7)(E) [redacted], and West Turkey Creek (Arizona Game and Fish Department 2001).

Management Requirements: Securing habitat and water sources are important management needs. See recovery plan (USFWS 1994).

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Yaqui Catfish (*Ictalurus pricei*)

The Yaqui catfish was designated as a federally Threatened species on August 31, 1984.

Historic range: Originally described from the (b) (7)(E), Sonora. Historical range most likely included the uppermost Rio Yaqui system, Arizona, and the basins of the Rio Yaqui and Rio Casas Grandes, Sonora and Chihuahua, Mexico (USFWS 1994). Now definitely known only from the Rio Yaqui basin, Mexico, though catfishes in other basins to the south may be this species. An introduced population existed in Arizona in the Santa Cruz River system (in a reservoir fed by Monkey Spring) from 1899 to the 1950s (Minkley 1973, Lee et al. 1980). As of the mid-1990s, stock was being held at Dexter National Fish Hatchery for future reintroduction onto the (b) (7)(E) in Arizona.

Basic Description: A small catfish.

Ecology Comments: Little information on life history available but probably similar to channel catfish (Minckley 1973). Grows rapidly and attains large sizes in ponds at Dexter NFHTC.

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, MEDIUM RIVER, Moderate gradient

Special Habitat Factors: Benthic

Habitat Comments: Small to medium rivers; most abundant in larger rivers in medium to slow currents over gravel/sand substrate.

Length: 50 cm

Management Requirements: Securing habitat and water sources is a major management need (USFWS 1994). Could be reintroduced in the (b) (7)(E) if sufficient habitat there can be secured and maintained. However, leases on geothermal resources granted by BLM on lands adjacent to the NWR possibly could result in a decrease in the already diminished water tables in the region, and the threat of pollution of groundwater could be increased. These threats are to be evaluated by BLM in consultation with the USFWS.

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Spikedace (*Meda fuldgida*)

The spikedace was designated as a federally Threatened species on July 1, 1986.

Historic Range: Upper Gila River basin, Arizona and New Mexico; formerly common throughout much of the Verde, Agua Fria, Salt, San Pedro, San Francisco, and Gila (upstream from Phoenix) river systems; to elevations of 1800-1900 m; range and abundance are now much reduced. Restricted to approximately 445 km of stream in in portions of the upper Gila River (Grant, Catron, and Hidalgo counties, New Mexico), middle Gila River (Pinal County, Arizona), lower San Pedro River (Pinal County, Arizona), Aravaipa Creek (Graham and Pinal counties, Arizona), Eagle Creek (Graham and Greenlee counties, Arizona), and the Verde River (Yavapai County, Arizona) (USFWS 1999). Current abundance ranges from very rare to common in the occupied range; common only in Aravaipa Creek and some parts of the upper Gila River in New Mexico (USFWS 1999).

Basic Description: A small fish (spikedace) up to about 8 cm long.

General Description: Adult spikedace are typically less than 70 mm in total length (TL), slim, and slightly compressed laterally. Scales are present only as small plates deeply embedded in the skin. The dorsal fin has a short base with usually seven rays, the first two being spinose, the anterior one being grooved to receive the second. The first spinous ray of the dorsal fin is stronger than the second, almost as long, and sharply pointed. Anal fins usually have 9 rays. Medial edges of the pelvic fins are adnate to the belly. The eyes and mouth are both relatively large and barbels are absent. Pharyngeal teeth are typically 1,4-4,1. The sides are silvery with vertically elongated black specks. The dorsum is olive-gray to brownish, usually mottled with darker pigmentation while the belly is white. Breeding males have a golden or brassy sheen, especially on the head and at bases of fins (Girard 1857, Miller and Hubbs 1960, Minkley 1973). Gilbert and Scofield (1898) and Miller and Hubbs (1960) noted the presence of rose or reddish colors. Even in the nonbreeding season the sides have been described as appearing "...like burnished silver..." (Miller and Hubbs 1960). Both sexes have breeding tubercles, but they are better developed, and therefore more visible, in males. Abarca (1990) suggested the following method for distinguishing between sexes: for males the eye diameter is greater than the distance between the distal end of the pectoral fin (when folded back parallel with the long axis of the body) and the origin of the pelvic fins; for females the eye diameter is equal to or less than the distance between the distal end of the pectoral fin and origin of the pelvic fins. Larvae have a nearly vertical mouth that makes them relatively easy to distinguish from other cyprinid larvae of the lower Colorado River Basin (Winn and Miller 1954). The spikedace is a member of the tribe Plagopterini (Miller and Hubbs 1960). Other species of this tribe in Arizona are the woundfin (*Plagopterus argentissimus*), Little Colorado River spinedace (*Lepidomeda vittata*), and Virgin River spinedace (*Lepidomeda mollispinis mollispinis*). These fishes, plus the introduced carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*), are the only cyprinid fishes in Arizona and New Mexico with fin rays modified as spines.

Diagnostic Characteristics: Characters that easily distinguish the spikedace from other Plagopterini in Arizona and New Mexico are the following: woundfin has a single barbel at each side of the upper jaw and an anal fin with 10 rather than 9 soft rays; Little Colorado River and Virgin River spinedace have visible scalation and the first spinose ray of the dorsal fin is weaker and obviously shorter than the second; carp and goldfish have long dorsal fins with more than 11 soft rays.

Reproduction Comments: Males evidently are not territorial but remain evenly spaced throughout a patrolled area. Females generally enter the area from downstream and are chased by males. The chase terminates when the female either strikes the bottom, or halts, in a group of males. Eggs are presumed to be spawned at this time (Barber et al. 1970, Minckley 1973). Breeding color and tubercles may appear as early as December and last until August (Minckley 1981). Breeding may be triggered by a combination of temperature and stream discharge (Propst

et al. 1986), as also documented for *Rhinichthys osculus* (John 1963). Gonads generally increase in size in February. Spawning first occurs in March when water temperatures reach approximately 19 C and proceeds until June (Minckley 1973, Anderson 1978), but mature ovaries have been noted in September (Minckley 1981). Propst et al. (1986) identified April as the peak breeding period and stated that spawning was completed by mid-May. Older females spawn earlier than younger females (Anderson 1978). Number of eggs per female ranges from 80 to 300 or more depending on female size. Anderson (1978) examined a sample of 29 females from the Gila River, 10 km south of Cliff, New Mexico; these ranged in size from 38 to 70 mm TL, with 88 to 246 mature ova per female. Anderson (1978) computed the relationship between female body size and fecundity as follows: number of ova = -152.85 + 5.61 TL (r = 0.844). Ovum diameter at spawning is near 1.5 mm. Age II females spawn at least twice per season, but most reproductive effort is by age I females (Barber et al. 1970, Anderson 1978, Sublette et al. 1990). Young first appear in April and May and reach 41 to 47 mm TL by November. Standard length (tip of snout to end of hypural plate) is related to total length by the following equation: SL = 0.85 TL - 0.12, r X r = 0.99, n = 100 (Marsh 1988). Total length averages 47 mm TL at the end of the first year, and 59 to 74 mm at the end of the second year. Sexual maturity occurs at about 40 mm in both sexes (Barber et al. 1970), and most become sexually mature in their second summer of life. Longevity typically is one to two years. Few live through their fourth summer and the largest individuals rarely exceed 70 mm (TL?) (Minckley 1973). Anderson (1978) reported an 81 mm TL female. Growth continues in the winter in Aravaipa Creek (Barber et al. 1970) but not in the cooler Gila River in New Mexico (Anderson 1978).

Ecology Comments: The spikedace is associated with a native fish fauna that includes roundtail chub (*Gila robusta*), loach minnow (*Tiaroga cobitis*), speckled dace (*Rhinichthys osculus*), longfin dace (*Agosia chrysogaster*), Sonora sucker (*Catostomus insignis*), and desert sucker (*Pantosteus clarki*). Historically, it was also associated with the woundfin (*Plagopterus argentissimus*), bonytail (*Gila elegans*), squawfish (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*), all now extirpated from the Gila River basin. Due to difficulties in tagging small fishes, movement patterns of spikedace adults are unquantified. Minckley (1981) showed that populations of spikedace in Aravaipa Creek increased following years of relatively high flow.

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Low gradient, MEDIUM RIVER, Moderate gradient, Pool, Riffle

Special Habitat Factors: Benthic

Habitat Comments: Favors permanent, flowing, unpolluted water of low gradient streams having pool, riffle, run, and backwater areas; sand, gravel, and cobble substrates with low to moderate amounts of fine sediment and substrate embeddedness; abundant aquatic insects; natural hydrologic conditions, including recurrent flooding; few or no predatory or competitive non-native species present; a healthy riparian community; and moderate to high bank stability (USFWS, Federal Register, 8 March 1994; USFWS 1999). In larger rivers, spikedace often are found in the vicinity of tributary mouths. Adults favor slow to swift velocities (0-100 cm/sec) in shallow water (3-38 cm) with shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at downstream riffle edges. Juveniles favor slow to moderate flow (0-60 cm/sec) in shallow water (3-70 cm) with moderate amounts of instream cover; shallow stream margins and backwater areas, over silt, sand, or gravel bottoms, adjacent to pools. Periodic spates that scour and clean sands and gravels are essential to feeding and reproduction (Sublette et al. 1990). See Barber and Minckley (1966),

Anderson (1978), Propst and Bestgen (1986), Propst et al. (1986), and Sublette et al. (1990) for further details. May partition habitat with red shiner in areas where the two species co-occur (Rinne 1991). Spawns over shallow (less than 15 cm deep), sand-gravel-bottomed riffles where water flow is moderate (Minckley 1973, Sublette et al. 1990). Eggs develop in sand or gravel at spawning site (Sublette et al. 1990). Stability of the substrate is likely important during times of egg deposition and hatching (Minckley 1981). Larvae occur in areas of slow to moderate flow (0-30 cm/sec) in shallow water (3-30 cm) with abundant instream cover. Habitat utilization in the Cliff-Valley reach of the Gila River was studied by Propst et al. (1986). Juveniles (26-35 mm TL) were found to occupy an average depth of 16.1 cm and average current speed of 16.8 cm/s. Adults (>36 mm TL) in the same reach occupied an average depth of 19.3 cm and current of 49.1 cm/s. Spikedace occupied swifter waters in the warmer months of June to November than in the cooler months of December to May. Although habitat availability was not recorded, Propst et al. (1986) believed this to be a real shift. Sixty-percent of larval spikedace were captured over sand-dominated substrate, 18% over gravel, and 18% over cobble substrates. Juveniles were found over gravel substrates (46%), sand-dominated substrates (45%), and cobble substrates (9%). Adults were captured over gravel substrates (47%), cobble substrates (32%), and sand-dominated substrates (19%). Rinne and Kroeger (1988) observed spikedace in Aravaipa Creek at an average depth of 20 cm and current speed of 35 cm/s over gravel and pebble substrates (3-64 mm diameter). Schools of 10 of more fish were found in deeper and slower water than solitary fish. Seasonal differences were documented in use of depths but not currents. Spikedace collected in December, February, and August occupied shallower depths than those collected in April, May, and September. Rinne and Kroeger stated these differences showed no discernible pattern and were probably related to availability.

Adult Food Habits: Invertivore, Piscivore

Immature Food Habits: Invertivore, Piscivore

Food Comments: Diet is mainly aquatic and terrestrial insects, such as larval baetid ephemeropterans, and secondarily other larval ephemeropterans, hydropsychid trichopterans, and chironomid and simuliid dipterans (Anderson 1978, Schreiber and Minckley 1981, Barber and Minckley 1983, Abarca 1989). Schreiber and Minckley (1981) reported that up to approximately 30% of the diet was made up of emerging or adult insects. Also eats (seasonally) some fry of other fish species. In pools, eats mayflies; diet is more diverse in riffles and runs. Dipteran larvae are most important for small individuals, mayfly adults and nymphs for adults.

Phenology Comments: Feeding activity peaks in late afternoon and early evening (Barber and Minckley 1983). Larval cyprinids in the Gila River of New Mexico were found to be primarily diurnal drifters; 87% of cyprinid larvae collected were in noon or dusk drift samples (Bestgen et al. 1987). Additionally, a ratio of 6.5:1, nearshore vs. midstream, in captured larvae was found in noon samples, but a 1:1 ratio was found in dawn samples.

Stewardship Overview: Existing populations must be carefully monitored and protected by eliminating detrimental water and land use and exposure to non-native fishes. Research is needed to identify specific aspects of these practices that result in the demise of spikedace. Spikedace are not the only native fish threatened, endangered, or extirpated from the Gila River Basin. An ecological approach that addresses the habitat needs of all native fish species is necessary to protect remaining populations of native fishes. Degraded habitat should be reclaimed and enhanced, and spikedace should be reintroduced where chances for success are judged good.

Restoration Potential: Recovery potential is good only if adequate suitable habitat within the present or historical range is vigorously protected. Remaining populations continue to be threatened by habitat modification, predation by and competition with non-native fishes, and continued introduction and dispersal of non-native fishes. Reestablishment of the spikedace into its former range is problematic until the causes of its demise are identified and corrected.

Preserve Selection & Design Considerations: Preserves should be in areas of designated Critical Habitat (see Federal Register, 8 March 1994, p. 10906).

Management Requirements: The following management needs were identified by Marsh (1988): protect existing populations not infected by non-native fishes by building fish barriers or enhancing natural barriers (barrier design should not significantly alter stream flow and the potential impact on natural upstream and downstream movements of native fishes should be assessed; barrier design must be approved by appropriate agencies and the Desert Fishes Recovery Team); identify target areas amenable to management; determine and implement necessary habitat and landscape improvements (including removal of non-native fishes); reintroduce populations to selected streams within historic range, ensuring that genetic considerations are addressed (local stocks with affinities to those formerly occupying target streams should be utilized for reintroduction; e.g., Aravaipa Creek for the San Pedro, Gila River for the San Francisco; stockings should be done according to guidelines set up by the American Fisheries Society, Desert Fishes Recovery Team, and the U.S. Fish and Wildlife Service); assure closure of potential immigration routes to preclude reinvasion of non-native fishes. Proper management and maintenance of riparian zones are essential to native fish populations. Changes in the riparian zone can affect leaf fall and energy flow, flow, natural cover, temperature, and deposition of eroded materials (Baltz and Moyle 1984). Of five riparian systems studied in Arizona, only Aravaipa Creek, where cattle have been excluded since 1973, showed successful reproduction and dominance of the broadleaf riparian community (Rucks 1984). Cattle-browsing is a major factor in the replacement of a broadleaf riparian community by a riparian scrub community (Rucks 1984). A change from a broadleaf to scrub riparian community can change energy flow, tree-fall cover, amount of shade, and stream temperature. Fire would be a preferred method of watershed management when necessary. However, the choice of fire as a management tool must take into account the fuel levels present. A crown fire ("hot fire") can lead to increased runoff and result in the filling of riffles or other spawning areas. The effects of a crown fire and subsequent runoff were reversed in three years in the upper Carmel River, California (Hecht 1984). Removal of spawning areas for a period of two to three years would cause local extinctions of spikedace due to their short lifespan. If watershed management is necessary, controlled burns, frequent enough to prevent build-up of high fuel levels, set during non-spawning periods or periods of decreased spawning activity (autumn), should be employed.

Monitoring Requirements: Known populations should be monitored biannually in the spring during the breeding season and in late autumn to check recruitment. Data are needed to distinguish natural fluctuations in abundance from population declines due to human-caused perturbation. Reintroduced populations should be monitored for success or failure. An immediate monitoring program is needed for Aravaipa Creek, Arizona, due to the recent discovery of red shiner in September 1990 (Minckley 1990). Additionally, the black bullhead has increased in abundance in Aravaipa Creek and may prey on spikedace (Marsh 1990); this situation should be monitored. Standardized monitoring techniques should be adopted so that data will be comparable over locations and time. Techniques could be those recommended by the Desert Fishes Recovery Team. Techniques available for determination of absolute abundance for fishes include depletion sampling, mark-and-recapture, passive capture devices, and underwater censusing. These may be modified or others developed specifically for application to spikedace. Such techniques should be adjusted as dictated by experience, and uniformly applied. Minckley (1981) found that 6 to 10 passes with an electroshocking device, in an area blocked off with nets, were required to capture 99% of the spikedace. Natural units of a stream should be sampled, i.e. riffles, pools, runs and channels, rather than predetermined distances. Then the natural units could be measured and the results reported as densities per habitat type.

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Gila Topminnow (*Poeciliopsis occidentalis occidentalis*)

The Gila topminnow is designated as a federally Endangered species.

Historic Range: Native range: Gila River system in Arizona and extreme western New Mexico; Rios de la Concepcion and Sonora, Sonora, Mexico. Currently occurs in the Gila river drainage, Arizona, particularly in the upper Santa Cruz River, Sonoita and Cienega creeks, and the middle Gila River; and in the Rio Sonora, Rio de la Concepcion, and Santa Cruz River (Weedman 1998). Extirpated in New Mexico; later reintroduced in New Mexico into a small pond on the Red Rock Wildlife Area, north of Lordsburg, in 1989; there is some question as to whether the fishes will be able to survive the cold winters of that area (Sublette et al. 1990).

Basic Description: A small fish (topminnow).

Reproduction Comments: In some areas reproduces throughout the year; in other areas breeding prolonged throughout spring and summer. Interval between broods apparently about 24 to 28 days. Depending on their size adults produce 1-15 young/brood (Minckley 1973). Life span apparently is about one year.

Habitat Type: Freshwater

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Low gradient, MEDIUM RIVER, Moderate gradient, Pool, SPRING/SPRING BROOK

Palustrine Habitat(s): HERBACEOUS WETLAND

Habitat Comments: Lowland and some upland streams of desert and grasslands, and margins of large, lowland rivers. Typical inhabitant of vegetated springs, brooks, and margins and backwaters of larger bodies of water (Lee et al. 1980). Prefers shallow, warm, fairly quiet waters but also can be found in moderate currents and depths up to 1 m; permanent and intermittent streams, marshes; preferred habitat has dense mats of algae and debris (usually along stream margins or below riffles) and sandy substrate sometimes covered with mud and debris (Matthews and Moseley 1990).

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Eats detritus and algae; also feeds opportunistically on aquatic invertebrates (Lee et al. 1980).

Length: 3 cm

Restoration Potential: In Arizona, attempts to eradicate *Gambusia* from sites with natural topminnow populations have been unsuccessful (*Gambusia* reinvaded); fencing to protect habitat from livestock resulted in vegetation encroachment and extirpation of the topminnow at another site.

Management Requirements: Minckley (1999) emphasized the need for protection of existing populations, establishment of populations in artifical refugia, and elimination, exclusion, or

management against introduced piscivores. See Marsh and Minckley (1990) for recommendations on methods for eradicating *Gambusia* (poison fish, reintroduce topminnow, frequently monitor system) and removing vegetation (cattle grazing may be best method). See Minckley et al. (1991) for detailed information on management and reintroduction efforts. See also Hendrickson and Brooks (1991) for information on transplantation efforts. High levels of heterozygosity, which correlate with enhanced survivorship and fecundity, make the Sharp Spring population (Arizona) the best choice for source of fishes for the restocking effort in the Gila River system (Quattro and Vrijenhoek 1989). The captive stock at Dexter National Fish Hatchery was replaced by fishes from Sharp Spring in the mid-1980s (Minckley and Deacon 1991). Based on patterns of molecular variation, Parker et al. (1999) recommended that each of the four watersheds in which subspecies *occidentalis* is still naturally extant be managed and conserved separately (see also Sheffer et al. 1997). Weedman (1998) cited the following needed actions: protect remaining natural and long-lived established populations; reestablish and protect populations throughout historical range; monitor populations and their habitats; develop and implement genetic protocol for managing populations; study life history, genetics, ecology, habitat, and interactions with non-native aquatic species; inform and educate the public and resource managers.

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Yaqui Topminnow (*Poeciliopsis occidentalis sonoriensis*)

The Yaqui topminnow has an implied federally Endangered species status because it is a subspecies of the federally endangered Gila topminnow (*Poeciliopsis occidentalis*).

Historic Range: Native range: Rio Yaqui basin in Arizona (b) (7)(E)) and several tributaries of the Rio Yaqui in Sonora, Mexico (Minckley et al. 1991, draft recovery plan). Hendrickson et al. (1980) found this fish to be widely distributed below elevations of 1300 m in the Rio Yaqui basin. Presently occurs in the U.S. at several locations within the (b) (7)(E) (draft recovery plan).

Basic Description: A fish (topminnow) that reaches a maximum length of about 6 cm.

Reproduction Comments: Breeds year-round where winter temperatures are ameliorated by spring flows, breeds mainly April-October otherwise; adult females produce broods of up to 20+ young at intervals of about 20 days; few live more than 1 year (USFWS 1994).

Habitat Type: Freshwater

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Low gradient, MEDIUM RIVER, Moderate gradient, Pool, SPRING/SPRING BROOK

Palustrine Habitat(s): HERBACEOUS WETLAND

Habitat Comments: Lowland and some upland streams of desert and grasslands, and margins of large, lowland rivers. Typical inhabitant of vegetated springs, brooks, and margins and backwaters of larger bodies of water (Lee et al. 1980). Prefers shallow, warm, fairly quiet waters but also can be found in moderate currents and depths up to 1 m; permanent and intermittent streams, marshes; preferred habitat has dense mats of algae and debris (usually along stream margins or below riffles) and sandy substrate sometimes covered with mud and debris (Matthews and Moseley 1990). On the (b) (7)(E) , occurs in shallows of artesian well outflows, ponds, and pool margins (draft recovery plan).

Adult Food Habits: Herbivore, Invertivore

Immature Food Habits: Herbivore, Invertivore

Food Comments: Detritus and algae; also feeds opportunistically on aquatic invertebrates such as amphipods and insect larvae (Minckley 1973, Lee et al. 1980).

Length: 3 cm

Management Requirements: Securing habitat and water sources are major management needs (USFWS 1994).

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Loach Minnow (*Tiaroga cobitis*)

The loach minnow was designated as a federally Threatened species on October 28, 1986.

Historic Range: Once locally common throughout much of the Verde, Salt, San Pedro, San Francisco, and Gila (upstream from Phoenix) river systems, Arizona, New Mexico, and Sonora, occupying suitable habitat in both the mainstreams and perennial tributaries, at elevations up to about 2200 m. Extirpated throughout much of its former range in Arizona. Occurred historically in the San Pedro River, Sonora, Mexico, but habitat there has been largely destroyed by diversion of water for agriculture. Now restricted to about 645 km of stream in portions of the upper Gila River (Grant, Catron, and Hidalgo counties, New Mexico), the San Francisco and Tularosa rivers and their tributaries Negrito and Whitewater creeks (Catron County, New Mexico), the Blue River and its tributaries Dry Blue, Campbell Blue, Little Blue, Pace, and Frieborn creeks (Greenlee County, Arizona, and Catron County, New Mexico), Aravaipa Creek and its tributaries Turkey and Deer creeks (Graham and Pinal counties, Arizona), Eagle Creek (Graham and Greenlee counties, Arizona), the White River (Apache, Gila, and Navajo counties, Arizona), and the Black River (Apache and Greenlee counties, Arizona) (USFWS 1999). Common only in Aravaipa Creek, the Blue River, and limited portions of the San Francisco, upper Gila, and Tularosa rivers in New Mexico (USFWS 1999). Marsh et al. (2003) reported a new record from North Fork of East Fork Black River, Arizona, and a rediscovered population in Eagle Creek, Arizona; the species recorded in the latter location in 1950 and the mid-1990s but has not been seen there since 1997.

Basic Description: A small fish (minnow), up to 6 cm long.

Reproduction Comments: In New Mexico, most spawners were in their second summer (Propst and Bestgen 1991). Spawning occurs in Arizona mainly March-June, with some breeding December-February; nests with eggs found also in September (Vives and Minckley 1990). Spring (e.g., April) spawning recorded in New Mexico. Female produces between 250 to 1,200 ova (Minckley 1973). Eggs hatch in about 6 days at 21 C. Male may provide some care to developing eggs (female also?) (Vives and Minckley 1990).

Habitat Type: Freshwater

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, High gradient, MEDIUM RIVER, Moderate gradient, Riffle

Special Habitat Factors: Benthic

Habitat Comments: Lives on bottom in permanent, flowing, unpolluted creeks and small to medium rivers of low to moderate gradient, low amounts of fine sediment and substrate embeddedness, abundant aquatic insects, and a healthy, intact riparian community with moderate to high bank stability; typically on turbulent riffles, sometimes in association with filamentous algae; habitat resembles that of many eastern darters (Percidae) (Lee et al. 1980). Obligate riffle-dweller, occurs in shallow (<20 cm) water over gravel/ cobble substrate (Rinne 1989, Propst and Bestgen 1991) or in interstices between rocks, often in association with eddying currents (Sublette et al. 1990). Adults inhabit moderate to swift (15-100 cm/sec), shallow (3-40 cm) water with gravel, cobble, and rubble substrates; juvenile habitat is similar but includes also sand substrates (Federal Register, 8 March 1994). Persists mainly in streams having relatively natural flow regimes and a predominance of native species (Propst and Bestgen 1991). Recurrent flooding is important in keeping substrate free of sediments and in helping this species

maintain a competitve edge over invading non-native fishes. Eggs are laid in cavities under flattened cobble (or uncemented cobble and rubble) in slow to swift (3-85 cm/sec), shallow (3-30 cm) water; eggs adhere to under surface (Sublette et al. 1990, Vives and Minckley 1990); males guard cavities and eggs. Larvae apparently use low velocity nursery areas: 0-30 cm/sec, 3-30 cm deep, with sand, gravel, and cobble substrates and abundant instream cover (Sublette et al. 1990; Propst and Bestgen 1991; Federal Register, 8 March 1994).

Adult Food Habits: Invertivore

Immature Food Habits: Invertivore

Food Comments: Restricted diet; feeds opportunistically on riffle-inhabiting insect larvae (e.g., simuliid dipterans and mayflies). Immatures feed pricipally on chironomids, adults eat various benthic insects (dipterans, mayflies, stoneflies, caddisflies) (Sublette et al. 1990, Propst and Bestgen 1991).

Length: 6 cm

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Huachuca Springsnail (*Pyrgulopsis thompsoni*)

The Huachuca springsnail was designated as a Federal Candidate species on September 12, 2006.

Historic Range: Range is the upper portion of the Santa Cruz and San Pedro River basins in Arizona and Sonora, Mexico. Originally it covered only six sites in Santa Cruz County, Arizona and Sonora, Mexico. These sites were: Cottonwood Springs, Monkey Spring, Canelo Hills Cienega, Sheehy Spring, Peterson Ranch Springs, and Ojo Caliente, (Hershler and Landye, 1988). Since that time, Landye in 1992 examined sixteen springs on (b) (7)(E) and found occurrences at nine springs. The nine additional sites are Upper Garden Canyon Spring, Lower Garden Canyon Spring, McClure Spring, Broken Pipe Spring, Cave Spring, Sawmill Canyon Spring, Upper Water Supply Spring, Lower Water Supply Spring, Blacktail Spring (Landye, pers. comm.). An additional site in Mexico was reported at Cienega Los Fresnos (Stefferud, pers. comm.).

Basic Description: a snail

General Description: This is considered a medium to large species relative to other Hydrobiidae snails, with a shell 1.7 to 3.2 mm long. The shell is ovate-conic with "3.25 to 5 moderately convex, slightly shouldered whorls". The aperture may be fused or separate from the body whorl. The pigmentation of the snout and anterior part of the foot tends from light to dark with the remaining portion and the head generally unpigmented. There appears to be some sexual dimorphism in two of four populations studied, in one case the males being larger than the females and vice versa in the other population. The identification is based upon characteristics of the reproductive organs. The penis which is considered moderate in size may be "squat to elongate". The ventral penial lobe surface has a glandular ridge, this is generally located at the tip of the lobe. The penial filament may be 35 to 103 per cent of the penis length and centered at 80 to 93% of the penis length. The whole of the penis exhibits a dark pigmentation. The testis and prostrate make up 37 to 54% and 7 to 8% of the body length, respectively. Between 55 and 85% of the bursa length is posterior to the albumen gland (Hershler and Landye 1988).

Ecology Comments: Little is known about the life history, biology or ecology of this small snail, but Landye (1993) suggested that it may be similar to another Hydrobiidae species, *P. morrisoni*, the Page Spring snail. The Page Spring snail experiences what appears to be a population crash in December and young appear in January.

Habitat Type: Freshwater

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): SPRING/SPRING BROOK

Palustrine Habitat(s): HERBACEOUS WETLAND

Habitat Comments: Habitat is restricted to springs and cienega wetland habitats. Within these habitats it is commonly found in shallow water on rocks around the spring sources.

Stewardship Overview: This snail occurs in cienegas and isolated springs in the upper Santa Cruz and San Pedro River drainages; a range-wide survey to determine the distribution is critically needed as is basic information on ecology, life-cycle, and population dynamics. Currently, the only management strategy is to maintain inhabited cienega and spring-fed wetland

habitat by (i) reducing the impacts of livestock on wetland vegetation, and ensuring bank stability and water quality; (ii) protecting the aquifer sources of these wetlands from groundwater pumping, water diversion, and pollution; and (iii) preventing erosion and incision of the stream channel through good land-use practices or construction of erosion-control structures.

Restoration Potential: Given the lack of knowledge about biology and ecology, including response to disturbance, recovery potential is unknown.

Preserve Selection & Design Considerations: Protection requires protection of wetland habitats, protection of the aquifer sources of these wetlands from groundwater pumping, maintaining channel stability upstream and downstream in the watershed (i.e., discouraging channel incision and erosion) and assuring high standards of water quality upstream. Within the site, protection requires maintenance of suitable firm (rocky) substrates, which seems to be a component of preferred habitat.

Management Requirements: With so little information, it is difficult to prescribe management directives. As a default, management should be targeted at maintaining the inhabited cienega and spring fed wetland habitat by (i) reducing the impacts of livestock on wetland vegetation, and ensuring bank stability and water quality; (ii) protecting the aquifer sources of these wetlands from groundwater pumping, water diversion, and pollution; and (iii) preventing erosion and incision of the stream channel through good land-use practices or construction of erosion-control structures.

Monitoring Requirements: It would be useful to assess the numbers of sites within the San Pedro and Santa Cruz River drainages. Based on the Landye 1992 survey, additional populations are likely to be found. Once a range-wide survey is completed, then one can begin to assess the nature and severity of threats. An important need is the development of a monitoring protocol to assess population size.

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Sonoran Tiger Salamander (*Ambystoma tigrinum stebbinsi*)

The Sonoran tiger salamander was designated as a federally Endangered species on January 6, 1997.

Historic Range: Santa Cruz and San Pedro river drainages, Santa Cruz and (b) (7)(E) counties, Arizona, including sites in the San Rafael Valley (SRV) and adjacent foothills of the (b) (7)(E) and (b) (7)(E) . The range of the subspecies and its occupied and potentially occupied habitat is thought to extend from the crest of the (b) (7)(E) west to the crest of the (b) (7)(E) , including the SRV and adjacent foothills from its origins in Sonora north to the Canelo Hills (USFWS 2002). Salamanders suspected of being Sonora tiger salamanders have been collected from Los Fresnos cienega in the School Canyon drainage approximately 3 km south of the border (Varela-Romero *et al.* 1992). Genetic testing showed that some SRV ponds contain salamanders with genetic characteristics similar to barred tiger salamanders. Salamanders with these *"mavortiu*m-like" sequences are more common on the outskirts of the SRV and ponds close to (b) (7)(E) Lake, which, because of prior use of imported waterdogs as fish bait, is where introduced barred tiger salamanders are expected to be found (Ziemba *et al.* 1998). Tiger salamanders have also been found in areas just outside the SRV, such as (b) (7)(E) , (b) (7)(E) , Copper Canyon, and (b) (7)(E) . Of these localities, genetic testing has only been performed on salamanders from the Fort, and with the exception of one pond within a kilometer of the SRV, salamanders on the Fort appear to be barred tiger salamanders (Andrew Storfer, University of Florida, pers. comm.) (USFWS 2002).

Basic Description: A robust salamander.

General Description: Metamorphosed terrestrial Sonora tiger salamanders have a color pattern ranging from "a reticulate pattern with an irregular network of light coloration, often coupled with light spots, on a dark background color", to a pattern of large, well-defined light or yellow spots or transverse bars, some of which encroach on the dark venter (Jones *et al.* 1988). Metamorphosed Sonora tiger salamanders measure from about 45 to 150 mm snout to vent length (SVL). Branchiate adults are gray to olive on the dorsum, head, and tail, and off-white to yellow on the ventral side. They have three external gills on each side of their head, and measure between 65 and 165 mm SVL. Male and female adult salamanders can be distinguished by the presence of two black folds of tissue (cloacal folds) on the caudal side of a male's vent. Larvae are gray on the dorsum, head, and tail, with little pigment on the ventral surface. They have external gills and hatch without legs, but grow hind and fore-limbs early in development (USFWS 2002).

Reproduction Comments: Breeds as early as January or as late as early May; breeding after monsoon rains in July and August is rare (Synder, cited by USFWS 2002). Some larvae hatched in spring metamorphose into terrestrial form from late July to early September; other individuals become sexually mature in the larval form or overwinter as immature larvae (USFWS 2002).

Non-Migrant: Yes

Locally Migrant: Yes

Long Distance Migrant: No

Mobility and Migration Comments: Movement patterns not thoroughly documented; most likely stay within a few hundred meters of their natal pond, but some may move 1.5-2.0 km or more between breeding and nonbreeding habitats or between ponds (see USFWS 2002).

Riverine Habitat(s): SPRING/SPRING BROOK

Palustrine Habitat(s): HERBACEOUS WETLAND, TEMPORARY POOL

Special Habitat Factors: Benthic, Burrowing in or using soil, Fallen log/debris

Habitat Comments: Cienegas, impounded cienegas, springs, livestock tanks; breeds mainly in cattle ponds or tanks (USFWS 2002). Adult, metamorphosed salamanders inhabit adjacent grassland and oak woodland terrestrial habitat when not in ponds (USFWS 2002). Mammal burrows or loosened soils outside the pond likely provide refugia for metamorphosed salamanders in the terrestrial environment, enabling them to burrow underground to avoid extreme environmental conditions (USFWS 2002).

Adult Food Habits: Carnivore, Invertivore

Immature Food Habits: Carnivore, Invertivore

Stewardship Overview: Recovery Criteria: The Sonora tiger salamander may be reclassified to threatened status when approximately 90 percent of salamander's currently-occupied range and approximately 90 percent of current breeding ponds are protected and maintained to prevent habitat loss and degradation, predator introductions, barred tiger salamander introductions, and collection of salamanders for bait. Scientifically credible monitoring over a five year period must indicate that the number of Sonora tiger salamander populations is not in decline and that there are no new factors that threaten the persistence of Sonora tiger salamanders (USFWS 2002). The Sonora tiger salamander will be considered for delisting when quantitative criteria in terms of number of breeding populations and amount, distribution, and type of available habitat are defined and met. Criteria will be based on research, continued monitoring, and population viability analysis. In addition, regulatory mechanisms and land management commitments must be implemented that provide for adequate long-term protection of the Sonora tiger salamander and its habitat. These commitments and mechanisms should address habitat maintenance and protection, management of non-native predators, disease transmission, introduction and collection of salamanders, interbreeding with non-native salamanders, and public education. Finally, the Sonora tiger salamander must be unlikely to need protection under the Endangered Species Act in the foreseeable future (USFWS 2002).

Actions Needed (USFWS 2002):

1. Maintain and enhance habitat where salamanders have been found, and create new habitat, if deemed necessary.
2. Control non-native predators (fish, bullfrogs, and crayfish) by enforcing and enhancing existing policies prohibiting the introduction and pond to pond transport of these taxa and by removing populations of non-native fish, bullfrogs, and crayfish.
3. Control introduction, transport, and collection of tiger salamanders in the San Rafael Valley by enforcing existing policies prohibiting these acts and by removing populations of barred tiger salamanders.
4. Create and enforce policies to minimize frequency of die-offs.
5. Monitor salamander populations and their habitat on public and, if permitted, private land, to observe threats as they arise and fulfill research objectives.
6. Conduct research to acquire demographic and dispersal information and develop a population viability analysis, better understand salamander disease, conduct genetic analyses, investigate reports of low pH, and determine distribution of crayfish and methods of crayfish removal.
7. Develop public education and information programs.
8. Practice adaptive management.

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Ramsey Canyon Leopard Frog *(Rana subaquavocalis)*

A conservation agreement among landowners and state and Federal agencies regarding the Ramsey Canyon leopard frog was implemented in 1997. It provides for captive breeding and reintroduction, acquisition of habitat, and habitat and population surveys (Federal Register, 19 September 1997).

Historic Range: Known from areas within a 10-km radius in the (b) (7)(E) ; current known range is limited to aquatic habitats in Tinker, Brown, Ramsey, and Miller canyons and several residential ponds in the area, (b) (7)(E) County, Arizona (Platz 1993, Platz and Grudzien 1993, Platz et al. 1997, Arizona Game and Fish Department 2001, Platz and Grudzien 2003). Currently exists in several canyons on the east side of the (b) (7)(E) (Goldberg et al. 2004). Ranges from 4,925 to 6,001 ft. (1502 - 1830 m) (Sredl et al. 1997).

Basic Description: A 3-4-inch frog.

General Description: A frog of the *Rana pipiens* complex, with prominent dorsal spots, dorsolateral folds, and extensive webbing on the hind feet. Snout-vent length 81-85 mm in adult males, 86-116 mm in adult females, and 60-62 mm in juveniles (type series, Platz 1993).

Diagnostic Characteristics: Differs from other members of the *Rana pipiens* complex by the following combination of chracters: "dorsolateral folds interrupted posteriorly and deflected medially; incomplete supralabial stripe (diffuse anterior to eye); enhanced melanism on venter; yellowish pigmentation on groin, which may extend onto posterior venter; numerous white papillae around cloacal aperture and adjacent dorsum and thighs; stocky body proportions; knob-like terminal swellings on toes in large adults; a long (average length 2.1 sec at 17 C), snore-like mating call consisting of 28-54 pulses of moderate pulse rate (averaging 19.6 pulses/sec at 17 C). The call is given entirely underwater (at a depth of 1.0-1.3 m) and is therefore inaudible in air" (Platz 1993). Differs from *R*. *yavapaiensis*, *R*. *pipiens*, and *R*. *blairi* by the presence of extensive mottling in the chin region. Differs from *R*. *pipiens* and *R*. *blairi* by lacking a well-defined, light-colored, complete supralabial stripe. Differs from *R*. *pipiens* also by lacking continuous dorsolateral folds and green axillary pigmentation, and by having external vocal sacs. Differs from *Rana berlandieri* by the stockier build of adults and by the yellow pigmentation in the groin region (occasionally present to a limited extent in *berlandieri*). Differs from *R*. *chiricahuensis* in larger adult size and expanded, knob-like toe tips in large adults.

Reproduction Comments: Males vocalize from at least mid-March through mid-July (Platz 1993). Egg masses have been recorded from mid-March through early October (AGFD, unpublished data). Mating seems to begin once water temperatures have reached at least 10 C (50 F), and oviposition may be correlated with temperatures rather than rainfall. Eggs hatch in about 14 days in the wild (Platz 1997). In captivity, eggs hatch in about 10 days when held at 23-25 C (73-77 F) (M. Demlong, unpublished data). Larvae metamorphose in the year they were oviposited or may overwinter as tadpoles (Platz and Grudzien 1993, Platz et al. 1997). Larvae metamorphose in as few as 100 days in captivity, but frequently take 160 to 200 days (M. Demlong, unpublished data). Platz (1997) suggested that sexual maturity is reached rather late in life, at approximately 6 years postmetamorphosis, but captive-reared frogs at the Phoenix Zoo and released in Miller Canyon produced egg masses one year after metamorphosis. Some individuals live at least 10 years after metamorphosis (Platz and Grudzien 1993, Platz et al. 1997). May have a lek breeding system, but further study is needed (Platz and Grudzien 1993).

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Mobility and Migration Comments: Although detailed study of movements has not been done, marked frogs have moved several hundred meters within Ramsey Canyon (M. Sredl, unpublished data) (Arizona Game and Fish Department 2001).

Riverine Habitat(s): CREEK, Low gradient, Moderate gradient, Pool

Palustrine Habitat(s): TEMPORARY POOL

Special Habitat Factors: Benthic

Habitat Comments: Habitats are found in pine-oak, oak woodland, and semi-desert grassland areas of the (b) (7)(E) . Vegetation at sites is variable but includes horsetail (*Equisetum* spp.), spikerush (*Eleocharis* spp.), cattail (*Typha* spp.), watercress (*Rorippa*), monkey flower (*Mimulus*), and grasses. Emergent vegetation and root masses provide cover sites (M. Sredl unpublished data) (Arizona Game and Fish Department 2001). Most occupied habitats are modified or artificial aquatic systems (Sredl et al. 1997). Ponds, streams, plunge pools are occupied. Adults and several tadpoles in upper Brown Canyon were found in a plunge pool (elev. 1675 m). Most of the frogs in Ramsey Canyon occupy a ground-level concrete tank (14 m X 14 m) approximately 1.3 m deep, fed by the natural stream adjacent to the tank; frogs also occur at various plunge pools along a 1000 m length of the stream, starting with plunge pools adjacent to the visitors' center and continuing above the tank population. Adults and larvae were observed at a small excavation in rock (a water pocket 2 m in diameter) 2 km below the entrance to Ramsey Canyon (Platz 1993). Occurs also in an earthen stock tank (Platz and Grudzien 1993). Males call while submerged, as may males of certain other RANA species. Eggs are laid in spherical masses, attached to submerged vegetation, so that the egg mass is held near the surface of the water (Arizona Game and Fish Department 2001).

Length: 10 cm

Management Requirements: Management needs include habitat restoration and removal of non-native species; captive rearing of larvae and release of juveniles began in 1995. Arizona Game and Fish Department (AGFD) is attempting to mitigate threats and enhance populations of Ramsey Canyon leopard frogs through captive rearing programs and translocations in the (b) (7)(E) of southeastern Arizona (Sredl et al. 2002). Eggs and larvae have been collected and reared in captivity to increase initial survival rates. The captive-reared frogs and larvae have been released at several sites including Ramsey Canyon, the Barchas Ranch, and Miller Canyon (Arizona Game and Fish Department 2001). An attempt to eradicate bullfrogs from Lower Garden Canyon Pond was unsuccessful (Sredl et al. 2002).

Biological Research Needs: Studies focusing on factors that may play a role in population declines, including the disease caused by chytridfungus, would be valuable (Arizona Game and Fish Department 2001).

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Chiricahua Leopard Frog (*Rana chiricahuensis*)

The Chiricahua leopard frog was designated as a federally Threatened species on June 13, 2002.

Historic Range: This species occurs from southeastern Arizona (drainages of the Madrean Archipelago and surrounding desert grasslands, south of the Gila River in (b) (7)(E) Santa Cruz, Pima, and Graham counties) and extreme southwestern New Mexico (Hidalgo County) in the United States, south along the eastern slope of the Sierra Madre Occidental in Sonora and Chihuahua, Mexico. It occurs at elevations of 1,060-2,010m in Arizona (Arizona Game and Fish Department 1995, Degenhardt et al. 1996, Sredel et al. 1997). Its southern range limit is poorly defined due to taxonomic uncertainties. See RANA SP 1 for information on the distribution of northern montane populations that may represent a different species.

Basic Description: A leopard frog.

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Riverine Habitat(s): CREEK, Pool, SPRING/SPRING BROOK

Lacustrine Habitat(s): Shallow water

Palustrine Habitat(s): Riparian

Special Habitat Factors: Benthic, Fallen log/debris

Habitat Comments: This species occurs in a wide variety of habitats at a wide range of altitudes in pine and pine-oak forests with permanent water ponds of moderate depth as well as montane streams. It is highly aquatic. It breeds in a wide variety of aquatic habitats, ranging from stock ponds, reservoirs, and lakes to spring-fed streams (Jennings and Scott 1993, USFWS 2000).

Adult Food Habits: Invertivore

Immature Food Habits: Herbivore

Food Comments: Adults mainly invertivorous. Larvae eat algae, organic debris, plant tissue, and minute organisms in water.

Phenology Comments: Inactive in cold temperatures.

Length: 14 cm

Management Requirements: See USFWS (2000) for information on management programs.

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New Mexico Ridgenose Rattlesnake (*Crotalus willardi obscures*)

The New Mexico ridge-nosed rattlesnake was designated as a federally Threatened species on August 4, 1978.

Historic Range: This snake occurs locally in Animas Mountains (New Mexico), Peloncillo Mountains (Arizona and New Mexico), and Sierra de San Luis (Sonora and Chihuahua, Mexico) (Campbell et al. 1989, Holycross and Smith 1997, Campbell and Lamar 2004).

Basic Description: A rattlesnake.

Reproduction Comments: Viviparous. Bears 2-9 young, August-September.

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: No

Palustrine Habitat(s): Riparian

Terrestrial Habitat(s): Bare rock/talus/scree, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed

Special Habitat Factors: Burrowing in or using soil, Fallen log/debris

Habitat Comments: Primarily at high elevations in pine-oak woodland and pine-fir forest but also found in foothill canyons in pinyon-juniper woodland. Inhabits canyon bottoms with canopies of alder, box elder, maple, etc. (Stebbins 1985). Hides in leaf litter among cobbles and rocks; frequently climbs into trees and shrubs (Matthews and Moseley 1990).

Adult Food Habits: Carnivore, Invertivore

Immature Food Habits: Carnivore, Invertivore

Food Comments: Preys on scorpions, centipedes, lizards, small mammals and birds.

Adult Phenology: Diurnal, Hibernates/aestivates

Immature Phenology: Diurnal, Hibernates/aestivates

Phenology Comments: Inactive in cold temperatures and extreme heat. Mainly diurnal but probably at least partially nocturnal during hot summer weather; in summer, most active on warm humid mornings; rains may stimulate late afternoon activity; in fall, active mainly in afternoon (Ernst 1992). Most active during daylight hours from July through September.

Length: 61 cm

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Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)

The western yellow-billed cuckoo was designated as a Federal Candidate species on September 12, 2006.

Historical Range: BREEDING: interior California to southern Idaho, southeastern Montana, the Dakotas, southern Manitoba (rarely), Minnesota, and New Brunswick, south to southern Baja California, southern Arizona, Coahuila, Chihuahua, Nuevo Leon, Tamaulipas, Gulf Coast, and Florida Keys; sporadically farther south in Mexico and in the Greater Antilles (AOU 1998). Uncommon on Cuba, Hispaniola, and Puerto Rico; rare in Virgin Islands, Jamaica, and northern Lesser Antilles (Saint Martin); possibly in Bahamas and Lesser Antilles (Raffaele et al. 1998). Bred formerly in British Columbia, Washington, and Oregon. NONBREEDING: southern Central America (rare and local in Costa Rica) and northern South America (and Trinidad and Tobago) south to eastern Peru, Bolivia, and northern Argentina (AOU 1998); rare in West Indies (Raffaele et al. 1998).

Basic Description: A bird (cuckoo).

Reproduction Comments: Breeding often coincides with the appearance of massive numbers of cicadas, caterpillars, or other large insects (Ehrlich et al. 1992). Clutch size is one to five (commonly two to three), largest when prey is abundant. Clutch sizes greater than six attributable to more than one female laying in nest (Hughes 1999). Incubation lasts 9-11, shared by male and female during day; male incubates at night (Hamilton and Hamilton 1965, Potter 1980, Potter 1981). Young are tended by both parents, climb in branches at seven-nine days. Sometimes lays eggs in the nests of Black-billed Cuckoo (*Coccyzus erythropthalmus*) or (rarely) other species (Ehrlich et al. 1992).

Ecology Comments: Territory size averages 20-24 hectares (S. Laymon, in Riparian Habitat Joint Venture 2000). Known predators of adults include Aplomado Falcon (*Falco femoralis*), Red-shouldered Hawk (*Buteo lineatus*), and other raptors; of eggs and young include Blue Jay (*Cyanocitta cristata*), Common Grackle (*Quiscalus quiscula*), Black Racer (*Coluber constrictor*) and Eastern Chipmunk (*Tamias striatus*) (Hughes 1999). Occasional host for Brown-headed Cowbird (*Molothrus ater*), Bronzed Cowbird (*Molothreus aeneus*), and Black-billed Cuckoo (*Coccyzus erythropthalmus*) (Hughes 1999).

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: Yes

Mobility and Migration Comments: Migrates regularly through the southern U.S., Middle America, and West Indies (sometimes large numbers in fall in Puerto Rico, Raffaele 1983). Birds from North America may migrate through Puerto Rico, but a small breeding population may be resident all year (Kepler and Kepler 1978). Migrants noted in April-May in Jamaica (Lack 1976). Migrates through Costa Rica mid-August to early November and late April-early June (Stiles and Skutch 1989). Arrives in California breeding grounds usually in early June (Biosystems Analysis 1989).

Estuarine Habitat(s): Scrub-shrub wetland

Palustrine Habitat(s): Riparian

Terrestrial Habitat(s): Forest - Hardwood, Forest - Mixed, Old field, Shrubland/chaparral, Suburban/orchard, Woodland - Hardwood, Woodland – Mixed

Habitat Comments: BREEDING: Open woodland (especially where undergrowth is thick), parks, deciduous riparian woodland; in the West, nests in tall cottonwood and willow riparian woodland. Nests in deciduous woodlands, moist thickets, orchards, overgrown pastures; in tree, shrub, or vine, an average of 1-3 meters above ground (Harrison 1979). Subspecies *occidentalis* requires patches of at least 10 hectares (25 acres) of dense riparian forest with a canopy cover of at least 50 percent in both the understory and overstory; nests typically in mature willows (Biosystems Analysis 1989). NON-BREEDING: forest, woodland, and scrub. Also mangroves in Puerto Rico (Raffaele 1983).

Adult Food Habits: Invertivore

Immature Food Habits: Invertivore

Food Comments: Eats mainly caterpillars; also other insects, some fruits, sometimes small lizards and frogs and bird eggs (Terres 1980). Gleans food from branches or foliage, or sallies from a perch to catch prey on the wing (Ehrlich et al. 1992).

Adult Phenology: Diurnal

Immature Phenology: Diurnal

Length: 31 cm

Weight: 64 grams

Stewardship Overview: Summer distribution throughout much of the eastern and Midwestern United States. Once common in the west, now rare and local, extirpated from British Columbia, Washington, Oregon, possibly Nevada. Winters primarily in South America east of the Andes, may breed in the tropics. Blue listed by Tate (1981). Western population currently under review for federal listing by USFWS; does not yet receive adequate federal due primarily to controversy surrounding the validity of its subspecies status. Listed as endangered in California, listed as threatened or endangered in every western state in which it occurs. From 1980 to 1994 eastern populations declined in all states except Louisiana and South Carolina. Highly significant declines in Alabama, Georgia, Illinois, Indiana, Michigan, New Jersey, New York, Ohio, Pennsylvania, Texas and Wisconsin, with the greatest decline in Connecticut. Main threats are habitat fragmentation, degradation of riparian woodland due to agricultural and residential development (Dobkin 1994), stochastic extinctions and low colonization rates, flood control (Laymon and Halterman 1987, 1989), riparian habitats invaded by less desirable salt cedar (TAMARIX spp.; Hughes 1999). Highly vulnerable to continued tropical deforestation (Morton 1992), but direct effects on population numbers not quantified. Preserves in the west should include riparian areas with dense stands of cottonwood and willow with an average tree height of 10-15 meters (Anderson and Laymon 1989). Preserves in the east should have open woodlands with clearings and low, dense, shrubby vegetation, associated with watercourses. Management should focus on acquiring and improving riparian habitats, and eliminating pesticide spraying near habitats.

Restoration Potential: May recolonize if suitable habitat is restored. On experimentally replanted sites (11 hectares) in southern California, foraged in second year and nested in third year following replanting, provided that cottonwood growth averaged 3 meters per year. Sites with growth of 2 meters per year or less not used for foraging or nesting by third year (Anderson and Laymon 1989).

Preserve Selection & Design Considerations: In California, Gaines (1974) defined habitat as willow and cottonwood forests below 1300 meters elevation, greater than 10 hectares in extent, and wider than 100 meters. Laymon and Halterman (1989) concluded that sites greater than 80 hectares (200 acres) in extent and wider than 600 meters (1950 feet) were optimal (100 percent

occupancy), sites 41-80 hectares (101-200 acres) in extent and wider than 200 meters (650 feet) were suitable (58.8 percent), sites 20-40 hectares (50-100 acres) in extent and 100-200 meters (325-650 feet) in width were marginal (9.5 percent), and sites less than 15 hectares (38 acres) in extent and less than 100 meters (325 feet) in width were unsuitable. During a four-year study on the Sacramento River, Halterman (1991) found that habitat patch area, the extent of habitat in a 8 kilometer (5 mile) section of river, and presence of low woody vegetation were the most important variables in explaining the distribution of cuckoos. These variables combined explained 46 percent of the variation observed in the distribution of breeding pairs. Microhabitat requirements are also important. Nesting groves at the South Fork Kern River are characterized by higher canopy closure, higher foliage volume, intermediate basal area, and intermediate tree height when compared to random sites (Laymon et al. 1997). Sites with less than 40 percent canopy closure are unsuitable, those with 40 - 65 percent are marginal to suitable, and those with greater than 65 percent are optimal (Laymon 1998). Lower nesting success for open-cup nesting birds near edges in large habitats and in smaller habitat fragments (Chasko and Gates 1982, Gates and Gysel 1978), and increased nest predation reaching up to 600 meters into forest interior (Wilcove 1985) indicate that reserves less than 100 hectares are less valuable than larger reserves (Wilcove et al. 1986). Simulation modeling demonstrates that populations of fewer than 10 pairs are very unstable and always become extinct in a short period of time (Richter-Dyn and Goel 1972, Roth 1974); a minimum number of 25 pairs in a subpopulation with interchange to other subpopulation should be reasonably safe from extinction by stochastic events (Hughes 1999). In the northeast and central U.S., and southern Canada, preserves should include woodland, abandoned farmland, overgrown fruit orchards, successional shrubland, dense thickets along streams and marshes (Johnsgard 1979, Peck and James 1983, Eaton 1988, Jauvin 1996), shade trees, gardens (Oberholser 1974). In midwest U.S., also uses willow-dogwood shrub wetlands, and successional hardwood forest with dense stands of small trees 1-7 meters in height; e.g., American Elm and or continuous stands of dense Hawthorn (Nolan 1963, Eastman 1991). In southeastern U.S. occupies hammocks and hardwood forest, particularly those crossed by streams, thickets, swamps, and fencerows (Stevenson and Anderson 1994).

Management Requirements: See California Department of Fish and Game (1990) for a listing of management needs in California. In the west, conservation recommendations summarized in Laymon (1980) include: determine numbers and locations of remnant populations; improve existing, and acquire new riparian habitats; eliminate pesticide spraying in orchards adjacent to riparian areas; and investigate feasibility of captive breeding and reintroduction to naturally regenerated or reforested habitat. Riparian vegetation propagation and site management techniques are outlined in Anderson and Laymon (1989). Grazing should be removed to allow natural regeneration and encourage increased density of cottonwoods and willows.

Monitoring Requirements: Population densities may be highly variable locally (Eaton 1988) depending on food availability; large localized influxes during times of insect abundances (Veit and Petersen 1993). Estimates made over 1-2 year period must be assessed with caution (Groschupf 1987). Population density may be underestimated due to quiet demeanor and skulking behavior, easily overlooked when silent. Conventional observation, mist netting (Rappole et al. 1993), or listening-post techniques are inadequate for estimating density; counting responses to playback is preferable (Hamilton and Hamilton 1965). Overlapping territories increase difficulty in monitoring and the only way to get a complete survey is to locate all or most of the nests which is a very time-consuming and difficult task (Laymon, pers. comm.).

Management Programs: On the South Fork Kern River, an experimental study using riparian restoration showed that the number of pairs is closely related to the amount of available habitat. This site had a restoration program which began in 1996 and has established 125 hectares (310 acres) of willow-cottonwood habitat on the Kern River Preserve, all of which was being used by cuckoos by the summer of 1996. An additional 510 hectares (1275 acres) of habitat was established by natural regeneration in the South Fork Wildlife Area and the Isabella Reservoir Draw-Down Zone between 1987 and 1992 (Laymon 1998).

Biological Research Needs: Need to determine cause(s) of declines in eastern and central populations.

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Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

The southwestern willow flycatcher was designated as a federally Endangered species on February 27, 1995.

Historic Range: BREEDS: southwestern U.S. (southern California north to Independence, Arizona, southwestern New Mexico, southern Utah, and, at least formerly, southern Nevada) and possibly northern Baja California and Sonora (very rare if present). Sedgwick (2001) studied distributional limits using distinctive song types of *E.T. extimus* and *E.T. adastus*, and found intergradation or overlap in southwestern Colorado and northwestern New Mexico. In areas of intergradation, there was some sorting of song types by elevation; birds with songs attributable to *E.T. extimus* were found as far north as 37 deg N at low elevation, whereas birds attributable to *E.T. adastus* were found as far south as 33.7 deg N at high elevation. The latter population occurred at over 2,400 meters in eastern Arizona. Occurred at least formerly in western Texas (current status uncertain) and northern Sonora. Some isolated remnant populations in southern California were allocated to subspecies *extimus* by Unitt (1987), but not by Phillips (1948). Population along the lower Colorado River now limited to about 20 pairs at Havasu National Wildlife Refuge (M. Romich, pers. comm. 2003). Formerly widespread in Arizona; now persist only in several small, widely scattered locations. Unitt (1987) noted that there was little recent information from Nevada and Utah. Unitt (1987) and USFWS (1993, 1995) included populations in areas of intergradation in the range of *E.T. extimus*. Winters: probably central Mexico to northwestern Colombia (Stiles and Skutch 1989). Migrates: in southern California, migrates through desert regions and sometimes along the coast and onto the Channel Islands (Biosystems Analysis 1989).

Basic Description: A small bird (flycatcher).

General Description: A flycatcher with brownish-olive upperparts, a whitish throat that contrasts with the pale olive breast, a pale yellow belly, and two light wing bars; generally lacks a conspicuous eye ring; as in other flycatchers, the bill is depressed and wide at the base (NGS 1983).

Diagnostic Characteristics: The palest subspecies of *E. traillii*; adults most closely resemble subspecies *adastus* but are even paler above, especially on the head, and *extimus* has a less pronounced chest band and the belly and crissum are paler yellow (Phillips 1948). Song differs from that of other subspecies by being a more protracted, slurred "fit-a-bew" with a burry "bew" syllable rather than a crisp, sneezy "fitz-bew" (USFWS 1995).

Reproduction Comments: Nesting occurs usually from early June through the end of July, peak in mid-June (Unitt 1987); sometimes may lay eggs as early as late May. In Grand Canyon, Arizona, breeds from early June to mid-July or perhaps early August (Brown 1988). Clutch size usually is 3-4 (2-3 along Colorado River). Incubation lasts 12-15 days, by female. Young are tended by both parents, leave nest at 12-15 days, usually in early to mid-July. Typically raises one brood per year. May incur a high rate of cowbird parasitism, especially in low elevation populations (e.g., Harris 1991, Brown 1988). Sometimes polygynous.

Ecology Comments: Breeding territories are about 1.5 acres. Densities may be on the order of 9-14 pairs/100 acres.

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: Yes

Mobility and Migration Comments: Present in California from late April to September (Biosystems Analysis 1989), in southern Arizona from early May to early or mid-September (Phillips et al. 1964). Arrives in Grand Canyon, Arizona, in mid-May (Brown, in Unitt 1987). Spring migration peaks in mid-May; fall migration extends from mid-August to early September (Biosystems Analysis 1989).

Palustrine Habitat(s): FORESTED WETLAND, Riparian

Terrestrial Habitat(s): Old field, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed

Habitat Comments: Thickets, scrubby and brushy areas, open second growth, swamps, and open woodland (AOU 1983). Restricted to riparian habitat in Arizona (Brown 1988). Nests primarily in swampy thickets, especially of willow, sometimes buttonbush (Phillips et al. 1964, AOU 1983), tamarisk (Brown 1988), vines, or other plants, where vegetation is 4-7 m or more in height. Tamarisk is commonly used in the eastern part of the range. Habitat patches as small as 0.5 ha can support one or two nesting pairs (see USFWS 1995). Nests in fork or on horizontal limb of small tree, shrub, or vine, at height of 0.6-6.4 m (mean usually about 2-3 m) (Harris 1991), with dense vegetation above and around the nest.

Adult Food Habits: Invertivore

Immature Food Habits: Invertivore

Food Comments: Eats mainly insects caught in flight, sometimes gleans insects from foliage; occasionally eats berries. In breeding range, forages within and occasionally above dense riparian vegetation.

Adult Phenology: Diurnal

Immature Phenology: Diurnal

Length: 15 cm

Weight: 11 grams

Management Requirements: In Oregon, willow flycatcher populations increased after reduction in cattle grazing and cessation of poisoning and removal of riparian willows (Taylor and Littlefield 1986). Harris (1991) recommended habitat restoration and reduction in grazing as the best long-term management strategies for reducing the rate of cowbird parsitism; trapping of cowbirds or removal of cowbird eggs may be useful short-term strategies to provide immediate reflief to critical populations. Brown (1988) cautioned against activities that would reduce or eliminate tamarisk (nesting habitat) in Grand Canyon, Arizona, and recommended that water releases from Glen Canyon dam be managed in such a way as to minimize streambank erosion and consequent reduction in riparian breeding habitat. See USFWS (1995) for further information.

Monitoring Requirements: Those doing field surveys should be aware that subspecies *brewsteri* is present (in migration) in the range of *extimus* during most of the latter's breeding season; surveys should encompass the period June 20 to July 15 and include repeated visits to verify that observed birds are resident and territorial (Unitt 1987).

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Northern Aplomado Falcon (*Falco femoralis*)

The northern aplomado falcon was designated as a federally Threatened species with a nonessential experimental population on February 25, 1986.

Historic Range: Historic breeding range: southeastern Arizona, southern New Mexico, and southern Texas south through Mexico (Tamaulipas, Chiapas, Campeche, Tabasco, Chihuahua, Coahuila, Sinaloa, Jalisco, Guerrero, Veracruz, Yucatan, and San Luis Potosi) to Guatemala (Pacific slope of Central American cordillera). Last verified breeding in the U.S. was in New Mexico in 1952 and in Texas in 1941 and 1995; unconfirmed report from Arizona in the late 1960s (AOU 1983); reintroduction is underway. Nests regularly only along Gulf Coast of Mexico in portions of northern and central Veracruz, northern Chiapas, western Campeche, and eastern Tabasco (Matthews and Moseley 1990). Unbanded individuals were recorded in New Mexico and Texas in the early 1990s. Historic winter range: Sinaloa, Chihuahua, and southern Tamaulipas south to southern Mexico; casual in Guatemala (AOU 1957).

Basic Description: A falcon.

Reproduction Comments: Egg-laying: January-June (mainly March-May, peak in April). Clutch size typically is 2-3. Both parents (mainly female) incubate, about 31-32 days (Cade 1982, Evans 1982). Young can fly at 4-5 weeks, may remain in nest area for several weeks more. Pairs remain together throughout the year (Palmer 1988).

Non-Migrant: Yes

Locally Migrant: Yes

Long Distance Migrant: No

Palustrine Habitat(s): Riparian

Terrestrial Habitat(s): Grassland/herbaceous, Savanna, Woodland – Conifer

Habitat Comments: Open rangeland and savanna, semiarid grasslands with scattered trees and shrubs; in U.S., was found in coastal prairies along sand ridges, in woodlands along desert streams, and in desert grasslands with scattered mesquite and yucca; has been found in open pine woodland in central Mexico (Matthews and Moseley 1990, Johnsgard 1990). Encroachment of thick tall grass of brush degrades habitat. Nests in old stick nests of other bird species (e.g., hawks, caracaras, ravens); in sites such as bromeliads in tropics. May sometimes nest on cliff.

Adult Food Habits: Carnivore, Invertivore

Immature Food Habits: Carnivore, Invertivore

Food Comments: Feeds primarily on birds (up to rock dove size), to a lesser extent on insects (moths, beetles, cicadas, orthopterans); uncommonly on small mammals, lizards, and snakes (Terres 1980, Cade 1982). Pairs often hunt together. Birds comprise most of diet biomass in eastern Mexico, but insects also are commonly consumed. Hunts from perch or air. See Palmer (1988) for further details. In eastern Mexico, hunted mainly within 1 km of nest site (Hector 1988).

Adult Phenology: Crepuscular, Diurnal

Immature Phenology: Crepuscular, Diurnal

Phenology Comments: Decidedly crepuscular in hunting habits, often catching prey after sunset; not very active in middle of day (Cade 1982). In eastern Mexico, preyed on birds mainly in the early morning, hawked insects later in the day (see Johnsgard 1990).

Length: 45 cm

Weight: 410 grams

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American Peregrine Falcon (*Falco peregrinus anatum*)

Historic Range: BREEDS: Across interior Alaska, south of the Brooks Range southeastward across Canada to Labrador, and south to Baja California and northern Mexico (Palmer 1988, Ambrose et al. 1988, Rowell 2002). Replaced on the coast of Alaska and outer coast of British Columbia by *F. p. pealei*. WINTERS: Those breeding in the boreal subarctic winter in South America; those at more southern latitudes exhibit variable migration behavior, and some are nonmigratory (USFWS 1999).

Basic Description: A medium-sized falcon.

General Description: A falcon with long pointed wings, a dark crown and nape, and a dark wedge extending below the eye; forehead is pale in immature, which are mainly brownish above rather than black or gray as in adults (NGS 1983).

Diagnostic Characteristics: Intermediate in coloration between the pale birds of the arctic (subspecies *tundrius*) and the very dark pergrines of the northwest coast of North America (subspecies *pealei*).

Reproduction Comments: Clutch size averages 4 at mid-latitudes, 3 in far north. Incubation lasts 32-35 days, mainly by female (male brings food). Young fledge at 39-49 days, gradually become independent. First breeds usually at 2-3 years, occasionally as yearling. Usually lifelong pair bond. Replaces lost clutches, usually at alternate site. Brood losses apparently caused mainly by bad weather. See many further details in Palmer (1988). In northwestern Arizona, mean distance between centers of nesting areas was around 6-8 km (Brown et al. 1992).

Ecology Comments: Great-horned Owl may be a serious nest predator in the U.S. Severe weather may result in high mortality in far north. Foraging range up to 27 kilometers (Martin 1979); home ranges in Great Britain varied from 44-65 square kilometers, and averaged 52 square kilometers (Brown and Amadon 1968). In Utah, home range radii varied from 0.3 to 29.8 kilometers, average 12.2 km (n = 19; Porter and White 1973).

Non-Migrant: No

Locally Migrant: No

Long Distance Migrant: Yes

Mobility and Migration Comments: Populations nesting in northern latitudes are highly migratory; those nesting in northern maritime climates, at mid-latitudes, and in the Southern Hemisphere much less so (Cade 1982). Tundra breeders migrate farthest, bypassing those farther south; a few winter in Florida, some in Caribbean, perhaps some in Central America, most in southern South America (Palmer 1988). Breeders from central Alaska migrated through central North America and wintered in southern Mexico, Central America, the Caribbean region, and South America (Britten et al. 1995). Two breeders from southern Utah migrated through western Mexico, and one continued to a wintering site in Nicaragua (Britten et al. 1995). In the U.S., the Atlantic coast from New Jersey to South Carolina and the barrier islands of the Texas Gulf Coast are important feeding areas for long-distance migrants. Arrives in northern breeding areas late April-early May; departure begins late August-early September (Johnson and Herter 1989). See Palmer (1988) for further information on timing of migration. From Padre Island, Texas, a northbound migrant reached south-central Canada in four days, and a southbound migrant passed through Mexico and reached Guatemala in six days (Chavez-Ramirez et al. 1994).

Estuarine Habitat(s): Bay/sound, Herbaceous wetland, Lagoon, River mouth/tidal river, Tidal flat/shore

Terrestrial Habitat(s): Bare rock/talus/scree, Cliff, Shrubland/chaparral, Urban/edificarian, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed

Habitat Comments: Various open situations from tundra, moorlands, steppe, and seacoasts, especially where there are suitable nesting cliffs, to mountains, open forested regions, and human population centers (AOU 1983). When not breeding, occurs in areas where prey concentrate, including farmlands, marshes, lakeshores, river mouths, tidal flats, dunes and beaches, broad river valleys, cities, and airports. Often nests on ledge or hole on face of rocky cliff or crag. River banks, tundra mounds, open bogs, large stick nests of other species, tree hollows, and man-made structures (e.g., ledges of city buildings) are used locally (Cade 1982). Nests typically are situated on ledges of vertical rocky cliffs, commonly with a sheltering overhang (Palmer 1988, Campbell et al 1990). Tundra populations nests typically on rocky cliffs, bluffs, or dirt banks. Ideal locations include undisturbed areas with a wide view, near water, and close to plentiful prey. Substitute man-made sites include tall buildings, bridges, rock quarries, and raised platforms. See Grebence and White (1989) for information on nesting along the Colorado River system.

Adult Food Habits: Carnivore

Immature Food Habits: Carnivore

Food Comments: Feeds primarily on birds (medium-size passerines up to small waterfowl); rarely or locally, small mammals (e.g., bats, lemmings), lizards, fishes, and insects (by young birds) may be taken. Prey pursuit initiated from perch or while soaring. May hunt up to several km from nest site (Skaggs et al. 1988). See Rosenfield et al. (1995) for information on food habits in Greenland.

Adult Phenology: Diurnal

Immature Phenology: Diurnal

Phenology Comments: In general, much hunting occurs in morning, and to lesser extent toward evening, but may hunt anytime during day.

Length: 51 cm

Weight: 1500 grams

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Bald Eagle (*Haliaeetus leucocephalus*)

Historic Range: BREEDING: central Alaska, northern Yukon, northwestern and southern Mackenzie, northern Saskatchewan, northern Manitoba, central Ontario, central Quebec, Labrador, and Newfoundland, south locally to the Commander and Aleutian Islands, southern Alaska, Baja California (both coasts), Sonora (Brown et al. 1988), New Mexico, Arizona, Texas Gulf Coast, and Florida (including the Keys); very local in Great Basin and prairie and plains regions in interior North America, where breeding range recently has expanded to include Nebraska and Kansas. NON-BREEDING: generally throughout the breeding range except in the far north (AOU 1983, Sibley and Monroe 1990), most commonly from southern Alaska and southern Canada southward. The Chilkat Bald Eagle Preserve, Alaska, supports the largest wintering population anywhere (Ehrlich et al. 1992). Winter concentrations occur in British Columbia-northwestern Washington, along the Missouri and Mississippi rivers, and in northern Arkansas. One of the largest fall (mid-October to mid-December) migrant concentrations (200-300 birds at any one time, close to a thousand individuals through the season) occurs at Hauser Lake near Helena, Montana.

Basic Description: Bald eagle. Mature adults have a white head and tail.

General Description: Adults have a white head, white tail, and a large bright yellow bill; elsewhere the plumage is dark. Immatures are dark with variable amounts of light splotching on the body, underwing coverts, flight feathers, and tail base; averages 79-94 cm long, 178-229 cm wingspan (NGS 1983).

Diagnostic Characteristics: Adults differ from other eagles in having both a white head and white tail (head of white-tailed eagle may look white at a distance). Bald eagle has a proportionately larger head and bill than does the golden eagle, in the immatures of which the white is confined to the base of the primaries and the base of the tail. Bald eagle lacks the long wedge-shaped tail of Steller's sea-eagle. Bald eagle's neck is shorter and tail is longer than in white-tailed eagle.

Reproduction Comments: Clutch size is 1-3 (usually 2). Incubation lasts about 5 weeks, by both sexes. Second hatched young often dies. Young first fly at 10-12.5 weeks, cared for by adults and may remain around nest for several weeks after fledging. Generally first breeds at about 5-6 years. Adults may not lay every year.

Ecology Comments: Commonly roosts communally, especially in winter. See Curnutt (1992) for information on the dynamics of a year-round communal roost in southern Florida. In Montana, the introduction of shrimp (*Mysis relicta*) had a cascading effect through the food chain, ultimately causing displacement of bald eagles (Spencer et al. 1991).

Non-Migrant: Yes

Locally Migrant: Yes

Long Distance Migrant: Yes

Mobility and Migration Comments: Most eagles that breed in Canada and the northern U.S. move south for winter. Migrates widely over most of North America (AOU 1983); moves generally E-SE across Canada and the Great Lakes region to the northeast coast of the U.S. In the northern Chesapeake Bay region, radio-tagged northern migrants arrived in late fall (mean date 21 December) and departed in early spring (mean date 27 March); radio-tagged southern migrants arrived throughout April-August and departed June-October (Buehler et al. 1991). See Palmer (1988) for fairly detailed review of seasonal movements in various regions. Defended territories are relatively small; 14 in Alaska varied from 11–45 hectares and averaged 23 ha (Hensel and Troyer 1964), and territory radius around active nests averaged 0.6 km in Minnesota

(Mahaffy and Frenzel 1987). Feeding home ranges surrounding active nests are undoubtedly much larger, depending on proximity to food sources and abundance of food. Minimum home range of breeding birds in Saskatchewan was 7 k^2 (Gerrard et al. 1992); on the Columbia River, Oregon, breeding home ranges averaged 21.6 k^2 (Garrett et al. 1993). Winter home ranges can be very large, especially for nonbreeding birds. An immature wintered in Arizona over an area of >40,000 k^2 and spent the summer in the Northwest Territories over a summer range of >55,000 k^2 (Grubb et al. 1994). Maximum distance between feeding area and night roost site was less than 16 km in winter in Missouri (Griffin et al. 1982). In north-central Arizona, February–April home range of immatures averaged 400 k^2; birds moved frequently and roosted singly or in small groups (Grubb et al. 1989).

Marine Habitat(s): Near shore

Estuarine Habitat(s): Bay/sound, Lagoon, River mouth/tidal river, Tidal flat/shore

Riverine Habitat(s): BIG RIVER, MEDIUM RIVER

Lacustrine Habitat(s): Deep water, Shallow water

Palustrine Habitat(s): FORESTED WETLAND, Riparian

Terrestrial Habitat(s): Cliff, Forest - Conifer, Forest - Hardwood, Forest - Mixed, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed

Special Habitat Factors: Standing snag/hollow tree

Habitat Comments: Breeding habitat most commonly includes areas close to (within 4.0 km) coastal areas, bays, rivers, lakes, or other bodies of water that reflect the general availability of primary food sources including fish, waterfowl, and seabirds (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990). Preferentially roosts in conifers or other sheltered sites in winter in some areas; typically selects the larger, more accessible trees (Buehler et al. 1991, 1992). Perching in deciduous and coniferous trees is equally common in other areas (e.g., Bowerman et al. 1993). Communal roost sites used by two or more eagles are common, and some may be used by 100 or more eagles during periods of high use. Winter roost sites vary in their proximity to food resources (up to 33 km) and may be determined to some extent by a preference for a warmer microclimate at these sites. Available data indicate that energy conservation may or may not be an important factor in roost-site selection (Buehler et al. 1991). In Saskatchewan lakes, density was positively correlated with abundance of large fishes (Dzus and Gerrard 1993). In winter, may associate with waterfowl concentrations or congregate in areas with abundant dead fish (Griffin et al. 1982); often roosts communally at night in trees that are used in successive years. Wintering areas are commonly associated with open water though in some areas eagles use habitats with little or no open water if other food resources (e.g., rabbit or deer carrion) are readily available. Avoids areas with nearby human activity (boat traffic, pedestrians) and development (buildings) (Buehler et al. 1991). Bald eagles usually nest in tall trees or on cliffs near water. Nest trees include pines, spruce, firs, cottonwoods, oaks, poplars, and beech. Ground nesting has been reported on the Aleutian Islands in Alaska, in Canada's Northwest Territories, and in Ohio, Michigan, and Texas. Nests located on cliffs and rock pinnacles have been reported historically in California, Kansas, Nevada, New Mexico, and Utah, but currently are known to occur only in Alaska and Arizona. Same nest may be used year after year, or may alternate between two nest sites in successive years. In British Columbia, nests with overhead canopy of foliage were most successful (Palmer 1988). See Livingston et al. (1990) for model of nesting habitat in Maine, Wood et al. (1989) for characteristics of nesting habitat in Florida (most nests in live pine trees). In Oregon, most nests were within 1.6 km of water, usually in largest tree in stand (Anthony and Isaacs 1989). In Colorado and Wyoming, forest stands containing nest trees varied from old-growth ponderosa pine to narrow strips of riparian vegetation surrounded by rangeland (Kralovec et al. 1992).

Adult Food Habits: Carnivore, Piscivore

Immature Food Habits: Carnivore, Piscivore

Food Comments: Feeds opportunistically on fishes, injured waterfowl and seabirds, various mammals, and carrion (Terres 1980). See Haywood and Ohmart (1986), Kralovec et al. (1992), Brown (1993), and Grubb (1995) for diet of inland breeding populations in Arizona, Colorado, and Wyoming. Hunts live prey, scavenges, and pirates food from other birds (e.g., osprey) and, in Alaska, sea otter (Watt et al. 1995, Condor 97:588-590). See Palmer (1988) for further information on hunting methods. In the Columbia River estuary, tidal flats and water less than 4.0 meters deep were important foraging habitats (Watson et al. 1991). See Caton et al. (1992) for information on foraging perches used in Montana. Sheep carcasses were significant food sources in winter in Oregon (Marr et al. 1995, Wilson Bulletin 107:251-257).

Adult Phenology: Crepuscular, Diurnal

Immature Phenology: Crepuscular, Diurnal

Phenology Comments: In the Columbia River estuary, foraging activity was most common at low tide and first daylight (Watson et al. 1991). In Arizona, foraging activity during the breeding season peaked at 0800-1000 and 1600-1900 MST (Grubb 1995).

Length: 94 cm

Weight: 5244 grams

Management Requirements: Recovery has been assisted by intensive management that included systematic monitoring, enhanced protection, captive breeding, relocation of wild birds, and publicity (Matthews and Moseley 1990). Knight and Knight (1984) recommended a 450 meter buffer between a human in a canoe and a feeding eagle. For northern Chesapeake Bay, Buehler et al. (1991) recommended a 1,360-meter-wide shoreline management zone that extends 1,400 meters inland to encompass nonbreeding roost sites and provide a buffer from human disturbance. Another study recommended a 250-m buffer between a human on land and an eagle in a shoreline tree. A 500-m buffer around the nest may be adequate (see Fraser et al. 1985). In Michigan, 75 percent of all alert and flight responses to human activity occurred when activity was within 500 m and 200 m, respectively; vehicles and pedestrians elicited the highest response frequencies. Anthony and Isaacs (1989) made recommendations for Oregon: size of areas for nest-site management should be 50-250 ha, with size and shape depending on surrounding vegetation, topography, and eagle behavior; human activities within 800 m of nests should be restricted from 1 January to 31 August; clearcut logging, road building, hiking trails, and boat launch facilities should not be allowed within 400 m of nests. In Arizona, pedestrians were the most disturbing human activity; eagles were more often flushed from perches than from nests and were most easily disturbed when foraging; eagle response to disturbance frequencies were 64% at distances less than 216 m, 45% at 216-583 m, and 24 at distances greater than 583 meters (Grubb and King 1991). Along northern Chesapeake Bay, flush distances because of approaching boats averaged 204 meters in winter, 176 meters in summer (Buehler et al. 1991, see for further information on the effects of human activity). In the Columbia River estuary, management of eagle foraging habitats should emphasize protection and enhancement of tidal flats (Watson et al. 1991). See Busch (1988) for a discussion of management activities in the southwestern U.S., Lefranc and Glinski (1988) for management recommendations. Supplemental feeding can be used in efforts to replace diminished supplies of natural foods, provide food free of environmental contaminants, provide essential nutrients, enhance survival of subadults, manipulate distribution of populations, increase nesting success, support released captive-bred birds, and/or afford opportunities for public viewing and education; potential disadvantages of supplemental feeding include prohibitive costs, the loss of natural and cautious behavior, dependence on these food supplies, which may alter migration patterns, and increased

potential for disease transmission (Knight and Anderson 1990). See Grubb (1980) for information on construction and use of an artificial nest structure.

Monitoring Requirements: See Fraser et al. (1983) for information on scheduling reproductive surveys. See Britten et al. (1995) for information on satellite telemetry.

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California Brown Pelican (*Pelecanus occidentalis californicus*)

The California brown pelican has an implied federally Endangered status because it is a subspecies of the federally endangered brown pelican (*Pelecanus occidentalis*), which was listed on November 15, 1994.

Historic Range: Breeds along Pacific coast of central and southern California (the Channel Islands south), on islands off Baja California and on islands in the Gulf of California (south to Isabella and the Tres Marias Islands); ranges regularly north of the breeding grounds to southern British Columbia (Johnsgard 1993, AOU 1998). [*Pelecanus occidentalis*: BREEDING: along Pacific coast from southern California to Peru and (where *thagus* is regarded as conspecific) central Chile, and along Atlantic, Gulf, and Caribbean coasts from Maryland south around Florida to southern Texas, Bahamas (Sprunt 1984), West Indies, off Yucatan Peninsula, and off Venezuela and Caribbean coast of Colombia. Ranges in Pacific coastal waters north to southern British Columbia (after breeding, before winter). NON-BREEDING: Ranges in Pacific coastal waters north to southern British Columbia (after breeding, before winter). In western North America, winters mainly from California south. In the southeastern U.S., primary winter range includes Florida and the Gulf Coast. Subspecies *carolinensis*: breeds locally in Maryland and Virginia and south to Florida (primary nesting range), also locally in Louisiana (where reintroduced) and in central coastal Texas; breeds locally also off northeastern Yucatan and Belize, and ranges southward through coastal Honduras and Costa Rica to Panama, where local breeding occurs off the Pacific coast; vagrants wander north to New England and occur casually inland to the Great Lakes and Great Plains states (Johnsgard 1993). Breeds also in the Bahamas (Sprunt 1984) (extirpated, according to Johnsgard 1993). Ranges throughout breeding range and along eastern shores of Mexico south along Central America to the Caribbean coasts of Colombia and Venezuela, and through the Greater and Lesser Antilles to Trinidad; and on the Pacific coast of Central America (AOU 1957). Subspecies *californicus*: breeds along Pacific coast in southern California (Anacapa Island), and in Mexico on islands off Baja California and on islands in the Gulf of California (south to Isabella and the Tres Marias Islands); possibly locally along the coast of Sonora and Sinaloa; vagrants have occurred north to British Columbia and Idaho (Johnsgard 1993).]

Basic Description: A large bird (brown pelican).

General Description: A large heavy water bird with a massive bill and huge throat pouch; wings and body are mostly grayish-brown; nonbreeding adult has a whitish head and neck, often washed with yellow; hindneck of breeding adult is dark chestnut; head and neck of juvenile is grayish brown; size varies greatly depending on location, with the smallest individuals in the West Indies, medium birds on the coasts of the U.S. (Atlantic and Gulf), Central America, and Colombia and Ecuador, large birds on the coasts of California, Mexico, and Galapagos Islands, and very large in Peru and Chile (NGS 1983, Palmer 1962).

Diagnostic Characteristics: Differs from subspecies *carolinensis* in being larger (e.g., average bill length 347 mm and 312 mm in males and females, respectively, vs. 319 mm and 294 mm) and, in definitive alternate plumage, the brown hindneck being much darker (sometimes almost black) (Palmer 1962). Differs from subspecies *occidentalis* in being much larger (average bill length of *occidentalis* 288 mm and 261 mm, for males and females, respectively) (Palmer 1962).

Reproduction Comments: Along the west coast of North America, egg laying may occur from late winter to early spring (peak usually in March or April but may vary among colonies and from year to year). Subspecies *carolinensis*: southern populations nest irregularly, usually beginning in late fall and extending through June; northernmost populations nest in spring and summer; intermediate populations nest, somewhat irregularly, in winter and spring. Clutch size averages between two and three. Incubation, by both sexes, lasts about 28-30 days. Young leave ground

nests at about 35 days, first fly at 71-88 days; leave nests in mangroves at about 63 days. May Some first breed at two years in some colonies (e.g., newly formed ones), possibly not until about four to seven years in stable populations (see Johnsgard 1993). Reproductive success varies with level of disturbance by humans, starvation of young, and/or flooding of nests, but typically the number of young fledged per nest averages one or less. See Johnsgard (1993) for information on productivity. Long-lived; reproduction tends to be "boom or bust." Colonies include up to 150 pairs in Trinidad.

Ecology Comments: Populations fluctuate considerably from year to year and from place to place.

Non-Migrant: Yes

Locally Migrant: Yes

Long Distance Migrant: Yes

Mobility and Migration Comments: Many stay close to nesting areas in winter. A portion of the eastern subspecies migrates to Florida, the Caribbean coasts of Colombia and Venezuela, and the Greater Antilles for winter. During cold winters, some Texas breeders winter along the Gulf Coast of Mexico. Individuals from breeding areas north of Florida winter mainly in Florida and Cuba; young and adults from Florida breeding colonies are more sedentary (young generally do not disperse more than 250 km from natal areas, adults may move up to 450-575 km from colony during the nonbreeding season) (Johnsgard 1993).

Marine Habitat(s): Near shore

Estuarine Habitat(s): Bay/sound, Lagoon, River mouth/tidal river, Scrub-shrub wetland

Terrestrial Habitat(s): Bare rock/talus/scree, Cliff, Sand/dune

Habitat Comments: Mainly coastal, rarely seen inland or far out at sea. Feeds mostly in shallow estuarine waters, less often up to 40 miles from shore. Makes extensive use of sand spits, offshore sand bars, and islets for nocturnal roosting and daily loafing, especially by nonbreeders and during the non-nesting season. Dry roosting sites are essential. Some roosting sites eventually may become nesting areas. BREEDING: Nests usually on coastal islands, on the ground or in small bushes and trees (Palmer 1962). Nests on middle or upper parts of steep rocky slopes of small islands in California and Baja California; usually nests on low-lying islands landward of barrier islands or reefs on Atlantic and Gulf coasts, where often nests in mangroves, sometimes in Australian "pines," red-cedars, live oaks, redbays, or sea grapes. In the subtropics and tropics, mangrove vegetation constitutes an important roosting and nesting substrate (Collazo and Klaas 1985, Schreiber 1979, Schreiber and Schreiber 1982). May shift between different breeding sites, apparently in response to changing food supply distribution (Anderson and Gress 1983) and/or to erosion/flooding of nesting sites.

Adult Food Habits: Piscivore

Immature Food Habits: Piscivore

Food Comments: Eats mainly fishes, especially menhaden, mullet, sardines, pinfish, and anchovies in U.S. waters; sometimes euphausiids; dives into water from air (USFWS 1980). Feeds by diving in deeper water, by swimming, sometimes in cooperative groups, in shallower water (Hilty and Brown 1986). Rarely reported scavenging or preying on eggs or young of water birds. Forages in shallow estuarine and inshore waters mostly within 10 km of the coast (Johnsgard 1993).

Adult Phenology: Crepuscular, Diurnal

Immature Phenology: Crepuscular, Diurnal

Phenology Comments: Most activity diurnal, little during twilight.

Colonial Breeder: Yes

Length: 122 cm

Weight: 3636 grams

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Mexican Spotted Owl (*Strix occidentalis lucida*)

The Mexican spotted owl was designated as a federally Threatened species on March 16, 1993.

Historic Range: Range extends from southern Utah (Kertell 1977, Marti 1979) and central Colorado (Webb 1983) south through the mountainous regions of Arizona (Ganey and Balda 1989), New Mexico, western Texas (Guadalupe Mountains), northern Sonora, Chihuahua, and Nuevo Leon south to Michoacan and Puebla (AOU 1983; USFWS 1994, 1995). Mexican occurrences documented during 1990-1993 were in the Sierra Madre Occidental, Sierra Madre Oriental, and Eje Neovolcanico, south to Aguascalientes; the Mexican portion of the range has not been thoroughly surveyed (USFWS 1995). Many populations in Arizona and New Mexico occur in relatively isolated mountain ranges, sometimes separated by large expanses of nonforested habitats; little is known of the populations in many of these mountain ranges; some ranges may include too little habitat to support spotted owl populations indefinitely without periodic immigration from neighboring ranges (Ganey, in Thomas et al. 1990). Abundance (density) is greatest in the central portion of the range; a little more than half of the U.S. population occurs in the Upper Gila Mountains Recovery Unit in Arizona and New Mexico (USFWS 1995). See USFWS (1995) for a spot map showing distribution based on observations made during 1990-1993.

Basic Description: Medium-sized, dark-eyed owl lacking ear tufts.

General Description: A large, dark-eyed, round-headed, brown owl with whitish spotting on the head, back, and underparts (spotted breast, barred belly).

Diagnostic Characteristics: Differs from other subspecies in being generally paler and having the lighter markings of the underparts more whitish (Ridgway 1914).

Reproduction Comments: Egg dates: peak in April in Arizona and New Mexico, sometimes as early as early March. Clutch size is 2-4, usually 2. Incubation, by female (fed by male), lasts about 30 days. Hatching generally occurs in early to mid-May. Young leave nest at about 5 weeks (June), fly at about 6-7 weeks, stay near nest for several weeks, fed by adults until late summer, independent by early fall (dispersal of young occurs in September-October). First breeds at 2-3 years; may not breed every year. Reproductive success generally is low (USFWS 1993); average number of young fledged per pair is about 1.0 (USFWS 1995).

Ecology Comments: Mostly solitary outside the breeding season. Home range size apparently varies with location and habitat; generally the smallest home ranges are a few hundred hectares and the largest ones are about 1500 ha (minimum convex polygon) (see USFWS 1995). In northern Arizona, mean home range of three pairs was 847 ha; owls shifted seasonally such that year-round home range was larger than the range used during any one season (Ganey and Balda 1989). Mean home range size of four pairs in the Lincoln National Forest was 1180 ha; mean home ranges in Utah varied from 242 ha in Zion National Park to 625 ha for two owls elsewhere (see USFWS 1993). In Utah, some home ranges shifted seasonally, others did not (see USFWS 1994). In general, fidelity to territories is apparently high (USFWS 1995). In Utah, seven juveniles dispersed 24-145 km (USFWS 1995). In New Mexico, five juvenile females dispersed 8-56 km (mean 22 km), five juvenile males dispersed 2-13 km (mean 6 km); some females, including an adult, made intermountain movements (Gutierrez et al. 1996). Density generally is less than 0.4/sq km (mostly about 0.1-0.2/sq km) (USFWS 1995). Annual survival rate appears to be about 80-90% in adults, 6-29% in juveniles (White et al. 1995, USFWS 1995).

Non-Migrant: Yes

Locally Migrant: Yes

Long Distance Migrant: No

Mobility and Migration Comments: In the southwestern U.S., apparently largely nonmigratory, with some vertical migration at higher elevations (Ganey et al. 1988) (i.e., owls move to lower elevations for winter, with some exceptions). Some owls remain year-round in the same general areas but exhibit seasonal shifts in habitat use pattern (USFWS 1995). Some migrate 20-50 km between summer and winter ranges (see USFWS 1995).

Palustrine Habitat(s): Riparian

Terrestrial Habitat(s): Cliff, Forest - Conifer, Forest - Hardwood, Forest - Mixed

Special Habitat Factors: Standing snag/hollow tree

Habitat Comments: Highest densities occur in mixed-conifer forests that have experienced minimal human disturbance (USFWS 1995, Ganey and Dick 1995). In the southwestern U.S., most common where unlogged closed canopy forests occur in steep canyons; uneven-aged stands with high basal area and many snags and downed logs are most favorable. In Arizona, occurs primarily in mixed-conifer, pine-oak, and evergreen oak forests; also occurs in ponderosa pine forest and rocky canyonlands (Ganey and Balda 1989). In Arizona, generally foraged more than or as frequently as expected (based on availability) in virgin mixed-conifer and ponderosa pine forests, and less than expected in managed forests; roosted primarily in virgin mixed-conifer forests; both foraging and especially roosting sites had more big logs, higher canopy closure, and greater densities and basal areas of both trees and snags than did random sites (Ganey and Balda 1994). In southern Utah, commonly used mesa tops, benches and warm slopes above canyons in fall and winter; relatively cool canyons were the primary summer habitat (see USFWS 1994). In New Mexico, breeding and roosting occurred in mixed-conifer forests that contained an oak component more frequently than expected by chance; generally did not use pinyon pine-alligator juniper woodlands for nesting or roosting; selected roost and nest sites in forests characterized by mature trees with high variation in tree heights and canopy closure greater than 75% (Seamans and Gutierrez 1995). Basically intolerant of even-age forest management practices (USFWS, Federal Register, 1 April 1994). Requires cool summer roosts (Barrows 1981, Ganey et al. 1993), such as near canyon bottoms, in dense forests, on shady cliffs or in caves (Ganey et al. 1988). Sometimes occurs in deep canyons in areas that lack extensive forests. Sometimes may winter in comparatively open habitats at lower elevations. Breeding formerly occurred in desert riparian habitat, but occurrences are rare in this habitat today. In general, foraging habitat requirements are not well known (USFWS 1995). See USFWS (1993, 1994, 1995) for further details on habitat. Nests on broken tree top, cliff ledge, in natural tree cavity, or in tree on stick platform, often the abandoned nest of hawk or mammal; sometimes in cave. In Utah and Colorado, most nests are in caves or on cliff ledges in steep-walled canyons; elsewhere, nests apparently most often are in trees, especially Douglas-fir (USFWS 1995, Seamans and Gutierrez 1995). Exhibits high level of nest site fidelity. Typically selects cool, shady sites with high canopy closure and at least a few old-growth trees, usually on moderate to steep slopes (USFWS 1993). In New Mexico, 61% of nest structures were on clumps of limbs caused by dwarf mistletoe infections; nest trees averaged 164 years old and 60.6 cm in diameter (Seamans and Gutierrez 1995). See also USFWS (1995).

Adult Food Habits: Carnivore

Immature Food Habits: Carnivore

Food Comments: Diet varies with location; woodrats, mice, and voles are common prey (USFWS 1995, Ward and Block 1995). Zion National Park, Utah: *Neotoma*, *Thomomys*, and beetles (Kertell 1977). Arizona: mainly cottontails, deer mice, woodrats, and voles (Ganey et al. 1988); also various birds, bats, lizards, and snakes (Duncan, 1992, Herpetol. Rev. 23:81). Arizona: mainly *Neotoma*, *Peromyscus*, *Microtus*, *Sylvilagus*, and *Thomomys* (Ganey 1992). Generally hunts from a perch. May cache prey.

Adult Phenology: Crepuscular, Nocturnal

Immature Phenology: Crepuscular, Nocturnal

Phenology Comments: Roosts during the day; hunts at dusk and at night. May leave roost during day to capture prey beneath roost, retrieve cached prey, or to drink or bathe in stream. In northern Arizona, calling peaked in late spring and during 2-hour period following sunset (Ganey 1990).

Length: 45 cm

Restoration Potential: Recovery plan (USFWS 1995) indicates that delisting could occur within 10 years (depends on results of monitoring over that period).

Preserve Selection & Design Considerations: Preserves should be distributed among the six U.S. and five Mexican recovery units designated by USFWS (1995). This subspecies probably exists as more or less discrete clusters of populations, reflecting the patchiness of the habitat; each cluster of populations (e.g., the Mogollon Rim cluster and the Southern Rockies cluster) apparently can be regarded as a classical metapopulation; owls disperse frequently within clusters but only rarely between clusters (Keitt et al. 1995).

Management Requirements: Management initially should focus on the alleviation of major threats: catastrophic wildfire and widespread use of even-aged silviculture; thereafter, other priorities, such as creating replacement owl habitat, should be pursued (USFWS 1995, which see for detailed management information). Manipulative experiments are needed to evaluate effects of fire (or other forest management activities) on owls (Bond et al. 2002). See also Dawson et al. (1987) and Lefranc and Glinski (1988) for management and research recommendations. See USFWS (1994) for a review of management policies and practices by agencies and tribes.

Monitoring Requirements: Monitoring of the population and habitat over the next 10 years is regarded as an essential part of the recovery plan (USFWS 1995). See USFWS (1995) for detailed information on monitoring procedures. See also Bull (1987) for information on capture techniques, Bosakowski (1987) and Forsman (1983) for census methods. See Ganey (1990) for cautions on censusing owls through calling surveys. Paton et al. (1991) concluded that the use of backpack-mounted radio tags should be avoided (due to impaired reproduction and survival of radio-tagged owls).

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Ocelot (*Felis pardalis*)

The ocelot was designated as a federally Endangered species on July 21, 1982.

Historic Range: Historical range: Texas, Louisiana, Arkansas, and Arizona south through Mexico, Central America, and South America to eastern Peru, eastern Bolivia, Paraguay, Uruguay, and northern Argentina. Occurs in the mountains of Colombia, Ecuador, and northern Peru, but not on the high plateaus of southern Peru and Bolivia (Kitchener 1991); recently recorded in Uruguay (see Kitchener 1991); to elevations of 1000 m. In the U.S., currently found regularly only in southern Texas (e.g., Laguna Atascosa National Wildlife Refuge, site of a recent radiotelemetry study). Occurrence in Arizona is based only on a few old records from the vicinity of Fort Verde and (b) (7)(E) (Hoffmeister 1986); documentation for these records is less than ideal.

Basic Description: A cat (ocelot).

General Description: A small spotted cat with a long tail; ground color ranges from whitish or tawny yellow to reddish gray and gray; dark markings form chainlike streaks, generally forming black-bordered elongated spots, which run obliquely down the sides; adult total length 92-137 cm, tail length 27-40 cm; mass 11-16 kg; greatest length of skull of adults, 120-158 mm (Hall 1981, Nowak 1991).

Diagnostic Characteristics: Differs from the jaguar in much smaller size (jaguar is 157-242 cm in total length) and pelage spots not forming distinct rosettes. Differs from *Felis wiedii* and *F. tigrina* in being larger (hind foot longer than 145 mm vs. shorter, greatest length of skull more than 120 mm vs. shorter, length of P4 more than 12.7 mm vs. shorter) (Hall 1981). Differs from young mountain lion in having spots arranged in rows or in a chainlike pattern.

Reproduction Comments: Texas: breeds in late summer. Births occur in fall and winter in Texas and Mexico (Leopold 1959). Tropics: breeds year-round. Gestation lasts about 70 days. Litter size is 2-4 (usually 2).

Ecology Comments: Population density in Costa Rica was estimated at 14-25/100 sq km (Kitchener 1991). In Brazil, Trolle and Kery (2003) used capture-recapture analysis of camera-trapping data to estimate density at 2.82 independent individuals per 5 sq km.

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Mobility and Migration Comments: Home range in Texas reportedly is a few square kilometers (Kitchener 1991). In Peru, adult females occupied exclusive home ranges of about 2 sq km; male ranges were several times larger, exclusive of those of other males, and overlapped multiple female ranges; individuals often were solitary but appeared to make contact with others frequently (Emmons 1988).

Palustrine Habitat(s): FORESTED WETLAND, Riparian

Terrestrial Habitat(s): Forest - Hardwood, Savanna, Shrubland/chaparral, Woodland - Hardwood

Special Habitat Factors: Standing snag/hollow tree

Habitat Comments: Habitats with good cover; when active by day, tends to keep hidden in dense brush (Emmons and Feer 1990). Inhabits dense chaparral thickets in Texas. Elsewhere, occurs in humid tropical forests, mangrove forests, swampy savannas, brushland, and riverine scrub in deserts. Where not hunted, adapts well to disturbed habitats around villages; often uses man-made trails (Emmons and Feer 1990). Mainly terrestrial but climbs, jumps, and swims well (Nowak 1991). Dens are in caves, hollow trees, thickets, or the spaces between the closed buttress roots of large trees; rarely climbs but sometimes may sleep on tree branch.

Adult Food Habits: Carnivore

Immature Food Habits: Carnivore

Food Comments: Feeds on various small to moderate-sized vertebrates: rodents, rabbits, and other small mammals; young deer and peccaries; birds (sometimes including domestic poultry); snakes; lizards; fishes; etc. Hunts and captures prey on the ground (Emmons and Feer 1990).

Adult Phenology: Crepuscular, Nocturnal

Immature Phenology: Crepuscular, Nocturnal

Phenology Comments: Nocturnal and diurnal; mainly nocturnal (Emmons and Feer 1990).

Length: 125 cm

Weight: 14000 grams

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Lesser Long-nosed Bat (*Leptonycteris curasoe*)

The lesser long-nosed bat was designated as a federally Endangered species on September 30, 1988.

Distribution: Central California (Constantine 1998), southern Arizona (e.g., Sidner and Davis 1988), and New Mexico to Honduras and El Salvador (Simmons, in Wilson and Reeder 2005). U.S. populations apparently winter in Mexico.

Habitat: The habitat in Mexico is primarily tropical deciduous forest and thorn forest (Arita 1991). In the United States, this bat roosts in old mines and caves at the base of mountains near alluvial fans vegetated with agave, yucca, saguaro, and organ pipe cactus (Barbour and Davis 1969). Young are born in maternity colonies in caves and mines.

Diet: Frugivore, Nectarivore

Threats: USFWS (1987, 1989) stated that the species was threatened by disturbance of roosts, loss of food sources through land clearing and human exploitation, and direct killing by humans. Overall, however, this species does not appear to be very threatened.

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Jaguar (*Panthera onca*)

The jaguar was designated as a federally Endangered species on July 22, 1997.

Historic Range: The jaguar once ranged throughout tropical lowlands of Mexico, Central America (now very rare except in Belize), and South America (to northern Argentina); in the United States, there are records from southern California, Arizona (Hoffmeister 1986, Johnson and Van Pelt 1997), New Mexico (Findley et al. 1975, Frey 2004), Texas (Schmidly 2004), and perhaps farther east in Louisiana; most records are from Arizona, where a minimum of 64 jaguars have been killed since 1900; some believe that a breeding population formerly existed in portions of the southwestern United States (Federal Register, 13 July 1994, 22 July 1997, which see for a state-by-state review of records). The species is now absent from much of the former range; it has been extirpated as a resident in most or all of the northern extent of the range in the southwestern United States and northern Mexico (see Federal Register, 13 July 1994, p. 35676, for discussion of recent records), El Salvador, Uruguay, developed areas of Brazilian coast, all but the northernmost parts of Argentina, and elsewhere. The largest remaining population is in Amazonian Brazil (Seymour 1989). In recent decades, jaguars occasionally have strayed into the United States in southern Arizona-New Mexico.

Basic Description: A large cat (jaguar).

Reproduction Comments: In tropical areas may breed throughout the year; births most common November-December in Paraguay, December-May in Brazil, March-July in Argentina, July-September in Mexico, June-August in Belize. Gestation lasts about 90-115 days. Litter size is 1-4 (average 2). Young begin to eat meat at about 10-11 weeks, though may suckle 5-6 months; remain in den about 1.5-2 months; stay with mother 1.5-2 year; females sexually mature in 2-3 years, males in 3-4 years (Seymour 1989).

Ecology Comments: Solitary and somewhat territorial, except during breeding season. Density estimated at 4/137 sq km in Brazil, 25-30 per 250 sq km in Belize (Seymour 1989). In Belize, daily home range may be only a few sq km, but may shift to new area every week or two. Home range in Brazil was estimated at 25-76 sq km (see Kitchener 1991). Major cause of mortality is hunting by humans.

Non-Migrant: Yes

Locally Migrant: No

Long Distance Migrant: No

Palustrine Habitat(s): Riparian

Terrestrial Habitat(s): Forest - Hardwood, Forest - Mixed, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed

Habitat Comments: Habitat includes a wide variety of situations, such as tropical and subtropical forests, lowland scrub and woodland, thorn scrub, pampas/llanos, desert, swampy savanna, mangrove swamps, lagoons, marshland, and floating islands of vegetation. At the southern extreme of the range, this cat inhabits open savanna, flooded grasslands, and desert mountains; at the northern extreme it may be found in chaparral and timbered areas. Young are born in a sheltered place such as a cave or thicket, under an uprooted tree, among rocks, or under a river bank (Seymour 1989).

Adult Food Habits: Carnivore

Immature Food Habits: Carnivore

Food Comments: Feeds on large and small mammals, reptiles and ground-nesting birds. Known to feed on peccaries, capybaras, tapirs, agoutis, deer, small crocodilians and turtles; opportunistic, see Seymour (1989) for further details. Hunts mostly on ground but may pounce on prey from tree or ledge.

Phenology Comments: Active throughout the year. Hunts primarily at night, but may be active day or night (Seymour 1989).

Length: 242 cm

Weight: 136000 grams

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Cochise Pincushion Cactus (*Coryphantha robbinsorum*)

The Cochise pincushion cactus was designated as a federally Threatened species on January 9, 1986.

Historic Range: (b) (7)(E) Co., Arizona and Sonora, Mexico. Despite intensive searching, this species is known only from 1 population in southeastern Arizona and 1 in adjacent Sonora, Mexico. Most of the plants are concentrated in small pockets of this tiny range, making the species especially vulnerable to cactus poachers; also potentially threatened by pesticides and mining.**Habitat Comments:** Grey limestone hills within a semidesert grassland, with small shrubs, other succulents, and grama grasses. About 1280 m elevation.

Threats: Habitat destruction from grazing, exploration and potential drilling for oil; collection; and off-road vehicles.

Reproduction: Lower reproduction rate than most cacti - estimated average annual production is 3 fruits with 20 seeds per plant.

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Lemmon Fleabane (*Erigeron lemmonii*)

The Lemmon fleabane was designated as a Federal Candidate species on December 6, 2007.

Historic Range: Known from a single canyon in the (b) (7)(E), (b) (7)(E) County, Arizona. Despite extensive searching for several years, only this one population is confirmed.

Habitat Comments: Crevices and ledges in limestone canyon walls and on vertical faces of large boulders along canyon bottoms. Surrounding vegetation is pine-oak woodland. 1920-2225 m elevation.

Threats: The greatest threat to *Erigeron lemmonii* is wildfire, which could be intense in the narrow canyon; an intense fire could directly kill individuals, desiccate plants, and alter habitat (Falk 2004). Measures have been taken to reduce the threat of wildfire (Falk 2004). Most plants are on cliff faces well above the heavy fuel loads (Stone 2003). Other potential threats include extended drought, major rock falls, and unauthorized rock climbing (Warren et al. 1991 cited by Stone 2003). Because the species is only known from one population, it is also especially vulnerable to catastrophic events. A management plan for the species has been developed. Rappelling, smoking, and leaving the trail are prohibited in Scheelite Canyon (Stone 2003).

Environmental Specificity: Narrow. Specialist or community with key requirements common.

Environmental Specificity Comments: Known only from crevices and ledges of west, south and north facing cliffs, and on vertical faces of large boulders along a single canyon. It is found on substrates of sandy silicate or granitic soils, and limestone outcrops, between 1920-2225 m (6,300-6,600 ft) elevation.

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Huachuca Water Umbel (Cienega False Rush) (*Lilaeopsis schaffneriana* var. *recurva)*

The Huachuca water umbel was designated as a federally Endangered species on January 6, 1997.

Historic Range: The distribution of *Lilaeopsis schaffneriana* var. *recurva* ranges throughout southeastern Arizona and adjacent Sonora, Mexico from Sonoita Creek on the west to Rio San Bernadino on the east. Historically the species reached north to Tucson and south to Cananea, Sonora. The Tucson population along the Santa Cruz River (type locality) no longer exists, presumably due to the loss of perennial flow in this area. The taxon is restricted within this range to small sites with specific wetland requirements. As of 1991, a total of 10 locations in the U.S. and 6 in Sonora, Mexico are known.

Technical Description: An herbaceous semiaquatic perennial with slender erect leaves that grow from the nodes of creeping rhizomes. The rhizomes are usually very shallow, only 1-2 cm underground. They occasionally run along the bottom of still ponds and are generally white. Rhizomes branch freely and may form dense mats in the sand or mud streambed, making it impossible to identify individual plants. The cylindrical hollow leaves, which are typically borne two or three per node, have septa at irregular intervals. The pale green leaves are generally 1-3 mm in diameter, but their length varies depending upon the microhabitat in which they grow. When growing out of the water in wet soil near a stream, the leaves are often only 3-5 cm tall; growing in water that supports their weight, leaves up to 20 cm or more have been observed (Affolter 1985). Three to 10 tiny flowered umbels arise from root nodes. The inflorescence peduncles are typically 1-5 cm tall and always shorter than the leaves. Peduncle length also varies depending upon microhabitat; when growing out of the water they may be only 1-2 cm long, but when under water they may reach 6-7 cm. The flowers are 1-2 mm wide with tiny maroon-tinted petals. The fruits are globose, 1.5-2 mm in diameter, and usually slightly longer than wide.

Diagnostic Characteristics: *Lilaeopsis schaffneriana* var. *recurva* grows in perennial, shallow and slow-moving water. Such sites are rare in southeastern Arizona and northern Sonora, Mexico. *Lilaeopsis* is difficult to locate in the field, in part because it usually occurs with and resembles another small wetland species, *Eleocharis charibea*. *Lilaeopsis* has semisucculent leaves that are somewhat flexuous, whereas *Eleocharis* leaves are pithy, strictly straight and not at all succulent. The leaves of *Lilaeopsis* also appear to be a pale yellow-green compared to the darker green of most co-occurring herbaceous species.

Ecology Comments: Affolter (1985) observed flowering specimens from collections made in June and August and fruiting specimens from May and July through early September. Nature Conservancy botanists have observed Lilaeopsis flowering abundantly only once (April 1988), as the local conditions were drying out at Cottonwood Spring along Sonoita Creek. Flowering at low frequency has also been observed from March through October. Affolter (1985) suspects that other members of the genus Lilaeopsis self-pollinate. Seed germination from plants grown in an aquarium has been observed. The seeds stuck to the aquarium sides after falling from the parent plants and germinated within 1-2 weeks after ripening (Warren, pers. comm.). Although seeds from *Lilaeopsis schaffneriana* var*. recurva* appear to germinate easily, vegetative reproduction via rhizomatous spreading and dispersal of dislodged clumps is clearly important. Liz Ecker, curator of the Living Collection at the Desert Botanical Garden, has a living specimen which has flowered and born fruit, but she has done no germination studies with the taxon to date (L. Ecker, pers. comm.). An experimental transplant program for *Lilaeopsis* was conducted at the (b) (7)(E) in 1991 in order to establish a second secure population on the refuge that would be less vulnerable to destructive flooding than the existing population on (b) (7)(E). Aside from securing a population, the project allows us to learn more about the ecology and habitat of the species for future management (Warren 1991). Three transplant sites were chosen at perennial ponds. The first transplant took place August 26, 1990; the two subsequent

transplants were made on March 2, 1991, with follow-up monitoring of the transplants done on April 26, 1991. The three transplant sites yielded different results. *Lilaeopsis* could not be relocated at the first transplant site. Competition with other herbaceous plants appeared to have wiped out the transplanted colony. At the second site the *Lilaeopsis* transplant persisted, but due to a moderate amount of surrounding competitive vegetation, the patch did not grow beyond its original 5-inch diameter. However, the third site which was relatively free of competing vegetation, showed tremendous growth and vigor - increasing from 5 inches to approximately 2 feet in diameter over the 1.5-month period. The major conclusion is that *Lilaeopsis* can not survive where there is heavy competition from other herbaceous aquatic plants. Shallow standing water, in contrast to flowing streams, is grown in quickly with aquatic vegetation. Therefore *Lilaeopsis* grown at ponds may need special management to reduce density and accumulated litter from competing vegetation. *Lilaeopsis* is a vulnerable taxon which is easily destroyed by heavy flooding and scouring of habitat, although it also appears to need some amount of disturbance to the habitat in order to decrease surrounding competitive vegetation. *Lilaeopsis* appears to grow year round in the absence of killing frost whereas other aquatic plants tend to die off during the winter, allowing *Lilaeopsis* to more effectively colonize open space following low-level disturbance.

Census data: The Nature Conservancy established and monitored transects at three *Lilaeopsis* locations in 1989. Transects were established at (b) (7)(E) in the (b) (7)(E) and another at (b) (7)(E) near (b) (7)(E) The location (distance along the transect), length, and width of every *Lilaeopsis* patch along permanent transects was recorded. The density of leaves in each patch was also estimated using a rank scale. Lowest density patches received a 0.5 ranking, and highest density patches ranked 3.0. The rank-density value for a sample of patches was correlated with actual stem counts in 12cm x 12cm quadrants to calibrate the scale. Using these counts, a mean density (number of stems per 0.01 square meters) was calculated for each density rank (Gori et al. 1990). Density and coverage of *Lilaeopsis* varies greatly from site to site. Percent coverage of *Lilaeopsis* varied among the sites from 11.5% to 58.3%; of the total area occupied by *Lilaeopsis*, 10.4% to 75.3% had a density value of 2.0 or greater. For specific data see Gori et al. (1990). Together these data provide a profile of the distribution and density of *Lilaeopsis schaffneriana* var. *recurva* along transects in 1989. Similar measurements in subsequent years will indicate what changes have occurred in these streams. The fate of individual patches can also be tracked since the position, length, width and estimated leaf density of every patch is mapped along each transect.

Related species: The genus *Lilaeopsis* contains 13 species of perennial, rhizomatous herbs which live in temperate and alpine regions of North and South America and Australasia. These plants grow in damp, marshy and aquatic habits, often in brackish water. *Lilaeopsis schaffneriana* is one of 4 strictly freshwater species in the genus. It occurs in southeastern Arizona, central and northern Mexico and northwestern South America (Affolter 1985). There is a great deal of morphological variation within *Lilaeopsis schaffneriana*. Some is due to local environmental conditions, as Affolter (1985) showed when he reared plants from the same stock in different depths of water and got great differences in leaf length. Genetic differences, on the other hand, could easily arise among small populations which grow primarily by rhizomatous spreading. Affolter (1985) recognized the Arizona populations as a distinct subspecies based on differences in fruit shape as well as the major geographical gap across the continental divide between the ranges of the Arizonan and Mexican groups. *Lilaeopsis schaffneriana* var. *recurva* inhabits disjunct locations in southeastern Arizona and northern Sonora. Known locations for *Lilaeopsis schaffneriana* var. *schaffneriana* are similarly separated on the central plateau of central and southern Mexico. This kind of distribution is expected for an aquatic species surrounded by arid lands. Affolter expressed suspicion that the discontinuity between the subspecific ranges might reflect a lack of exploration for the plant. However, it is significant that the two subspecies of Lilaeopsis are found on opposite sides of the continental divide. So the predominant dispersal mechanism for the species, water, could not serve to mix populations (Warren 1991). *Lilaeopsis masonii* is a candidate category 2 species of northern California. It grows along the margins of rivers, sloughs, and islands of the San Joaquin-Sacramento River

delta (California Fish and Game 1988); there are approximately 30 known occurrences. *Lilaeopsis masonii* differs from L. *schaffneriana* var. *recurva* in that it is found in intertidal zones of brackish water marsh. It grows far enough inland so it does not grow directly in salt water as some species of *Lilaeopsis*, but the water is brackish and the plants do experience tidal fluctuation (R. Bittman, pers. comm.). *Lilaeopsis masonii* grows in dense mats at water margins. Associated species are: marsh pennyworts (*Hydrocotyle umbellata* and *H. verticillata*), three-ribbed arrow grass (*Triglochin striata*), mudwort (*Limosella subulata*), tules (*Scirpus* spp.), rushes (*Juncus* spp.), and Suisun marsh aster (*Aster chilensis* var. *lentus*). *Lilaeopsis masonii* grows from an elevation of sea level to 25 feet. It flowers from April to October. Little is known about the ecology/biology of this species (R. Bittman, pers. comm.). The primary threats to *Lilaeopsis masonii* are proposed water projects which involve dredging, rip-rapping, levee construction, and other alterations to natural banks and river channels. Heavy cattle grazing also occurs at some of the sites. Petroleum processing plants exist in the area and the species is vulnerable to oil spills. One spill impacted two populations in 1988. The long-term effects of oil on the species is unknown (California Fish and Game 1988). No recovery programs are currently necessary for *Lilaeopsis masonii*, but the species is of interest here because proposed management for the species includes an experimental transplant program. Rip-rap work has been proposed along Barker's Slough in Solano County. This could potentially destroy dense colonies of *Lilaeopsis masonii*. A project to transplant all *Lilaeopsis masonii* at the rip-rap sites to suitable habitat has been proposed. Information gained from California's transplant program may prove useful to our efforts at managing *Lilaeopsis schaffneriana* var. *recurva*.

Habitat Comments: Cienegas (mid-elevation wetland communities), riverine systems, and springs at about 1150-2130 m elevation. Usually in wet soils along the periphery of a channel, in backwaters, or in small openings in the understory near springs. Does not tolerate much competition with other species, but will quickly colonize open habitat created by scouring floods and persist there until interspecific plant competition becomes too great. In order for populations to expand, some plants must remain in areas that escape the effects of periodic scouring floods. *Lilaeopsis schaffneriana* var. *recurva* is restricted to cienega habitats, which are marshy or meadow-like wetlands surrounded by semiarid vegetation (Warren 1991). Hendrickson and Minckley (1984) describe three different types of cienegas based on elevation: low, mid, and high elevation cienegas. Low elevation cienegas or subtropical marshes occur mostly along major perennial rivers below 3000 feet. The low elevation Lileaopsis sites have experienced the most disturbance both human and natural. Low elevation cienega habitats were probably river backwaters and floodplain seeps. These locations are very unstable, experiencing cycles of flooding and drying due to varying climatic patterns. Human influence including groundwater pumping and diversion of water for irrigation have eliminated perennial flow in most southeastern Arizona rivers. Perennial flow is essential for wetland formation. This loss of habitat is evident in the disappearance of 4 historic locations of the taxon. Grazing has added to the problem by contributing to watershed deterioration, which exacerbates erosive flooding and further destabilizes cienega habitats. There are 2 known sites occurring at low elevation on the same stream; one is in the San Bernadino National Wildlife Refuge, in the U.S., and the other in Sonora, Mexico near the border along the Rio San Bernadino. Mid-elevation cienegas occur between 3000-6000 feet. This elevation range fits Hendrickson and Minckley's (1984) definition of true cienega habitat. Permanent water is available and a unique wetland community has developed at these sites (Warren 1991). Flooding potential is lower at these cienega sites because they have smaller drainage areas. Also, the gradients are gentler at these mid-elevation sites as opposed to the higher elevation cienegas. There are 6 current U.S. locations for *Lilaeopsis* at mid-elevation sites, and 4 in Sonora; they are: Bear Canyon, Lone Mountain Canyon, Cottonwood Spring, San Rafael Valley (3 springs) and Turkey Creek in Arizona, and Ojo de Agua de Cananea, Rio San Rafael, Arroyo Los Fresnos and along the Rio Magdalena in Sonora. Flooding, however, is still a potential problem at this elevation range as demonstrated by the population at Cottonwood Spring, which was seriously reduced by flooding from Hog Canyon in 1988. Grazing also has a negative impact on this watershed. High elevation cienegas occur at elevations over 6000 feet. They are described by Hendrickson and Minckley (1984) as "marshy to bog-like alpine and cold temperate meadowland." They may form in surface depressions that

fill with water or at stream headwaters. There are few potential sites for *Lilaeopsis* at these elevations because usually these higher sites are in canyons with stream gradients too steep to support cienega wetlands. Three high elevation sites of *Lilaeopsis* are known in the (b) (7)(E) [redacted] One is in upper Scotia Canyon and another in upper Garden Canyon. An additional *Lilaeopsis* population is reported in Sunnyside Canyon from 6050-6200 feet (S. McLaughlin, pers. comm.). The surrounding vegetation of the cienega communities varies with elevation. Willow (*Salix* spp.) and cottonwood (*Populus* spp.) trees, cattails (*Tyogys* spp.), large reeds, bulrush (*Scirpus* spp.), and halophytes in nearby saline areas are typical of desert-scrub communities of the low elevation cienega sites. Rushes, grasses, fewer cattails, semiaquatic sedges, watercress (*Nasturtium officinale*), water pennywort (*Hydrocoytle americana*), halophytes in adjacent saline areas, and trees (not as common with willows being the most common) are the dominant species of the grassland/oak woodland habitat of mid-elevation cienegas. Finally, the high elevation community is conifer forest including cold-resistant sedges and rushes, semiaquatic and terrestrial grasses, and low, woody alder (*Alnus* spp.) and willow (*Salix* spp.) shrubs. Physical factors, particularly hydrological conditions such as watershed area and stream gradient, appear to limit the distribution of *Lilaeopsis schaffneriana* var. *recurva*. The taxon appears to have specific requirements which limit its distribution to perennial water, gentle stream gradients, small- to medium-sized drainage areas and mild winters. Weather and precipitation data (NOAA 1986) from stations within the range of Lilaeopsis: At Canelo 1 NW station in Santa Cruz County, the data are summarized as follows: elevation 5010'; N latitude 31 33'; W longitude 110 32'; mean annual precipitation 17.06"; January mean temperature (F) 42.2; July mean temperature (F) 74.2; and annual mean temperature (F) 57.2.

At (b) (7)(E) FAA station in (b) (7)(E) County, the data are summarized as follows: elevation 4098'; N latitude 31 28"; W longitude 109 36'; mean annual precipitation 12.16"; January mean temperature (F) 44.9; July mean temperature (F) 79.1; and annual mean temperature (F) 61.6. Because the *Lilaeopsis* sites are so dispersed, climatic data provided here are relatively non-specific. Populations inhabit the physiographic province known as the Sonoran Desert Section of Basin and Range. The hydrologic regime appears to be a critical aspect of *Lilaeopsis* habitat. In an effort to characterize hydrologic conditions at each site, we estimated site substrate stability and watershed gradient above the site based on visual observations of the sites. We have made a somewhat arbitrary classification of stream channel conditions at each site as "stable" or "unstable" based on the condition of herbaceous vegetation along the stream bank and channel: stable sites are those where the stream banks, and part or all of the channel, are well stabilized by herbaceous vegetation; unstable sites are those where the channel and much of the banks are unconsolidated, shifting alluvium. Under present watershed conditions, 10 square miles appears to be a watershed size threshold above which flooding is too severe for *Lilaeopsis* to persist, although larger watershed area may be mitigated by low gradient, as at San Bernadino. This taxon does not tolerate much competition with other species, but will quickly colonize habitat disturbed by scouring floods and persist there until interspecific plant competition becomes too great. In order for populations to expand, some plants must remain in areas that escape the effects of periodic floods (Rutman and Rorabaugh 1995).

Stewardship Overview: High priority needs include protecting perennial stream flow through acquisition of water rights; management of the watershed to assume a good vegetative cover by perennial grasses to prevent scouring floods and monitoring known populations to detect downward trends if they occur. Working with private landowners is a high priority since several sites are on private land.

Restoration Potential: At present there is not enough evidence of a decline in the populations to require a recovery program. However, it is important to maintain existing populations at their present levels to guard against any possible future decline. The species shows evidence of successful reproduction at all known sites indicating a high recovery potential. The experimental transplant program at San Bernadino shows a high survivorship rate given suitable growing conditions (ie. few surrounding competitive species).

Preserve Selection & Design Considerations: Adequate protection of *Lilaeopsis* populations requires consideration of the direct site impacts as well as indirect effects of water supply and watershed condition. Therefore, primary site boundaries may be relatively small and include only the wetland habitat where *Lilaeopsis* is found. Secondary site boundaries should include key portions of the watershed to be managed for maintenance of water supply and erosion control. An important protection consideration is the acquisition of water rights to ensure stable future water levels. Various privately owned sites should be protected through continuing land owner education and assistance. These sites should be put in protective ownership if the opportunity presents itself.

Management Requirements: The primary management need of *Lilaeopsis schaffneriana* var. *recurva* is to protect the cienega habitat that supports known populations. Management procedures include protecting water supplies by acquiring instream flow water rights and managing watersheds to reduce flood frequency and intensity. Continued monitoring of the known populations and surveys for other potential locations should also be part of the management procedure. Recreation management may be necessary at some local populations. Prescribed burns may be essential for certain populations to reduce the density of accumulated litter from competing vegetation.

Monitoring Requirements: Continued monitoring every other year of existing populations is needed in order to determine whether the populations are stable, increasing or declining and subject to nearby threats. Three of the 12 known sites have been monitored by The Nature Conservancy since 1989. The percent coverage and density of the species were determined along transects (Gori et al 1990).

Management Programs: This element is not being actively managed.

Monitoring Programs: One program underway since 1989. Contact: Peter Warren, Public Lands Protection Planner, The Nature Conservancy, Arizona Field Office, Tucson, Az.

Management Research Programs: One research program involving transplant populations was conducted by The Nature Conservancy in 1991 and is being monitored at the San Bernadino National Wildlife Refuge.

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Madrean (Canelo Hills) Ladies Tresses (*Spiranthes delitescens*)

The Madrean ladies tresses was designated as a federally Endangered species on January 6, 1997.

Historic Range: Four populations of *Spiranthes delitescens* have been found in Arizona: (b) (7)(E) County, above the dam in Babocomari Cienega; Santa Cruz County, along Turkey Creek, at O'Donnell Cienega, and on a slope below Sheehy Spring (Sheviak 1990). This species most likely exists in Mexico; however, to date, no plants have been located south of Arizona (Sheviak 1990). The occurrence of other populations of this species of Ladies' Tresses in the United States is probably unlikely due to the limited available sites possessing the specific habitat parameters which appear to be required by these plants (Sheviak 1990).

Diagnostic Characteristics: *Spiranthes delitescens* can be distinguished from other Mexican and southwestern United States *Spiranthes* species by the shape of its medium-sized flowers: the floral tube curving into a horizontal apex and an ascending base, and the sepals curving outward and downward. In addition, the pubescence is distinct; the trichomes are glandular-capitate and taper at the apex. Cytological differences between *S*. delitescens and other *Spiranthes* species also exist (Sheviak 1990).

Reproduction Comments: Flowers, Pollination and Hybridization: Orchid flowers have a unique morphology which has coevolved with their pollinators (van der Pijl and Dodson 1966). A large petal, called the labellum or lip, acts as a landing platform for many pollinators. In *Spiranthes* spp., balls of sticky pollen grains, pollinia, are positioned near the column (the partially united stamen and pistil) in such a way that when the pollinator enters the floral tube, on its way to the nectaries, it inadvertently triggers the rostellum causing the pollinia to be deposited on the pollinator (van der Pijl and Dodson 1966). Bees are the primary pollinator for *Spiranthes*, with Bombus being the most common genus; other pollinating organisms include flies, moths, and butterflies (van der Pijl and Dodson 1966; Dressler 1981). Within three days of successful pollination, *Spiranthes* flowers dehydrate and become discolored (Catling 1982). One pollinia contains over 10,000 pollen grains. This allows for efficient fertilization of the thousands of ovules in the ovaries of most orchids (van der Pijl and Dodson 1966). Some orchids are self-fertile, but most often fertilization is the result of outcrossing. Self-pollination is advantageous when plants have extended their range into areas not previously inhabited by the species (Dressler 1981). *Spiranthes* are often self-fertilized, and individuals that require cross-pollination are receptive for only 10 to 40 days (Catling 1982). Flowers older than 40 days contain dead ovules (Catling 1982). Within three weeks of pollination the seeds are fully developed and the ovary splits. Usually 100% of *Spiranthes* ovaries expand, but often only 50% of them contain seeds (Catling 1982). Orchids easily hybridize; both inter-specific and inter-generic hybrids occur in the wild (Sanford 1974). In dry climates, flowering often occurs during the rainy season. Flowering of the *Spiranthes* occurs in July, when temperatures range from 60°F at night to 100°F during the day and when the majority of the year's 15 to 20 inches of precipitation falls (Merrigan 1990; The Nature Conservancy Arizona Field Office, pers. comm.). In some cases too much rain, possibly causing a decrease in pollinator activity, results in a decrease in the number of flowers and consequently the number of fruits (Dressler 1981). Most nontropical species release their seeds in the fall at the beginning of the dormant period (Dressler 1981). In addition to moisture dependency, flowering of some species of *Spiranthes* is photoperiodically induced (Catling 1982). The age of sexual maturity is dependent on the species and can range from several years to over twenty years (Stoutamire 1974; B. Jennings, pers. comm. 25 Jan. 1990). Inflorescences first develop in *Spiranthes spiralis* thirteen to fifteen years after seed germination (Wells 1981). Once reproductively mature, the age of the plant is not a factor in flowering, whereas temperature and precipitation appear to be significantly related to the percentage of flowering plants (Wells 1981). *Spiranthes diluvialis* will not bloom in dry years when precipitation levels are atypically low (B. Jennings, pers. comm. 25 Jan. 1990). *S. spiralis* plants which have reverted back to the saprophytic stage are capable of flowering during the initial year of resuming above-ground growth (Wells 1967). The average percentage of flowering *S. spiralis* plants over a thirteen year

period was 33, ranging from 73% in 1966, 19% in 1970, 43% in 1973, down to 1% after the 1976 drought, and recovering to 31% the following year (Wells 1981).

Ecology Comments: *Spiranthes* of Canelo Hills Cienega and Turkey Creek: The grass-like leaves of the orchid, growing low in the sedge and horsetail fields, are difficult to see for most of the year. The inconspicuous plants are visible July and August when the roughly 20 cm tall inflorescences develop (P. Sundt, pers. comm. 23 Jan. 1990; The Nature Conservancy Arizona Field Office, pers. comm.). The fruits mature approximately three weeks after the flowers form, usually during the end of August, releasing hundreds of tiny seeds from each capsule to be dispersed, probably via the wind (McClaran and Sundt 1992; P. Sundt, pers. comm. 23 Jan. 1990). Many inflorescences are damaged during the summer; Sundt (pers. comm. 23 Jan. 1990) feels that grasshoppers may be responsible for the broken stalks and the chewed capsules. The life-cycle of the plants is unclear. Most likely these orchids are perennial; however, no dormant underground structures have been identified (McClaran and Sundt 1992). Determining the over-wintering structure is difficult without disturbing the plants. The plant may remain below-ground most of the year or, common to many *Spiranthes*, small, inconspicuous leaf rosettes may grow throughout the cool months, hidden by the tall vegetation (McClaran and Sundt 1992; B. Jennings, pers. comm. 25 Jan. 1990). In February, an inspection of approximately 40 flagged areas (presumably indicating the previous year's orchids) revealed no above-ground orchid structures (Newman 1990). Plants rarely flower in consecutive years and the relationship between the flowering plants cannot be elucidated since the growth pattern of the subterranean structures is unknown (McClaran and Sundt 1992). Censusing of the *Spiranthes* at Canelo Hills began in 1978; however, accurate assessment of the demographic patterns is difficult because varying techniques were used during the first eight years of monitoring. With this caveat in mind, the total number of plants in O'Donnell Canyon fluctuated from 40 in 1978, 196 in 1979, dropping to 30 in 1982 through 1984, and then increasing to roughly 80 plants in 1988 (McClaran and Sundt 1992). These data suggests that the number of flowering plants has declined since 1979. Few conclusions can be drawn from the data, considering that the early measurements were based on the number of flowering plants and the later censusing was based on the total number of plants (flowering and not flowering), and that individual plants would appear one year, not appear the following year (no visible above-ground structures), and then reappear in subsequent years. In fact, it is difficult to estimate population size based on counts of aboveground plants due to the lack of information concerning the life-cycle and environmental requirements of *Spiranthes delitescens*. Other species of *Spiranthes* grow initially underground saprophytically for many years, revert back to saprophytic growth when environmental conditions are not favorable and flower irregularly. Population declines followed by recoveries are characteristic of many *Spiranthes*. The plants growing at Turkey Creek appear to be in a plant community characterized by shorter plant height and greater alpha diversity than at Canelo Cienega. Grazers have been excluded from the latter location since 1969, when this part of Canelo Hills was bought by The Nature Conservancy; Turkey Creek is currently grazed (McClaran and Sundt 1992; P. Sundt, pers. comm. 23 Jan. 1990). Thus, although soils and topography of the two sites differ, grazing is also a likely factor differentiating the two sites. The population in Turkey Creek, ranging from hundreds to thousands of plants, appears healthier and more vigorous than the Canelo Hills' population (McClaran and Sundt 1992; M. Heitlinger, pers. comm. 8 Jan. 1990; P. Warren, pers. comm. 25 Jan. 1990). Sundt (pers. comm. 23 Jan. 1990) proposes that the Turkey Creek plants have always been more vigorous than the O'Donnell Creek plants, due to the different characteristics of the particular sites, and that little significant change has occurred in the two populations over time.

***Spiranthes* and Other Terrestrial Orchids**

Seeds and Fruits: Terrestrial orchid fruit are usually thin-walled, dry, and papery (Dressler 1981). Depending upon the species, *Spiranthes* fruit may mature within a few days after fertilization or may take as long as one year to completely develop (Luer 1975). Seeds of terrestrial orchids tend to mature and are dispersed at the end of the plants' growing season, which often coincides with the time of maximum germination (Stoutamire 1974). When fully

mature, the valves on the capsule open and the wind-borne seeds are dispersed (Luer 1975). Water and humans have also been implicated in orchid seed dispersal; there is no evidence supporting the involvement of non-human animals (Sanford 1974). Orchid seeds have been found 400 miles from the parent plant; without human intervention, however, dispersal rarely occurs this far (Sanford 1974). Orchid seeds are rudimentary when dispersed; the sole protection of the undifferentiated embryo is the seed coat, and no endosperm or other form of nourishment surrounds the embryonic plant (Luer 1975; B. Jennings, pers. comm. 25 Jan. 1990). Due to the naked, unprotected seed structure a dormancy period is highly unlikely and the period of viability relatively short (Stoutamire 1974; B. Jennings, pers. comm. 25 Jan. 1990). The rapid dispersal, lack of dormancy, requirement for specific fungi, and necessity of precise environmental conditions explains the extremely low seed survival rate of an estimated one in a million (Stoutamire 1974; Luer 1975; B. Jennings, pers. comm. 25 Jan. 1990). Cultivated Orchids: Terrestrial orchids are difficult to grow due to the specific symbiotic associations often required. Dimmitt (pers. comm. 22 Jan. 1990) does not know of any amateur orchidist having successfully germinated and cultivated any member of the genus *Spiranthes*. Although limited, laboratory and greenhouse experiments have uncovered some information on the germination and growth of terrestrial orchids. The seeds of many *Spiranthes* species retain their viability for three years when stored in a refrigerator (Stoutamire 1974). *Spiranthes cernua* seeds germinate readily in sterile water; *S. orchioides* seeds swell with imbibition but fail to germinate (Stoutamire 1974). When placed under a light source after germination, several *Spiranthes* species produce chlorophyll; this indicates an ability to grow autotrophically in the absence of a mycorrhizal associate. However, other species require sterile agar media, containing mineral salts and an external source of organic carbon, indicating an obligate heterotrophic (required mycorrhizal associates) stage (Stoutamire 1974; Dressler 1981; Arditti 1982). Arditti (1982) lists the specific media requirements for laboratory growth of many *Spiranthes* species. No information is available about the early growth requirements of *S. porrifolia* and *S. vernalis*, the putative parents of the southern Arizona plants. When plants are grown in sterile laboratory conditions, light is required for normal development of many early photosynthesizing species, but it may inhibit the germination of the late-photosynthesizing species (Stoutamire 1974). A protocorm develops from the undifferentiated embryo and is the initial external structure when seed germination commences (Sanford 1974; Stoutamire 1974). Two stages of high mortality are found in agar-grown seedlings: the first stage occurs shortly after the protocorm emerges from the seed coat, when it reaches 1 mm to 2 mm in length, and the second stage occurs shortly after the roots develop. In the wild this later stage correlates with the transitional period when the seedling changes from an obligate mycorrhizal dependent to a partly autotrophic organism (Stoutamire 1974). In the lab, seedling growth initially occurs in the downward direction and after several centimeters of growth the apical meristem turns and grows upward (Stoutamire 1974); in *Spiranthes* the protocorm initially forms into the tubercle (Sanford 1974). During the first year of growth, short thickened corms or modified lateral buds, called sinkers, are formed in most terrestrial orchids (Stoutamire 1974). *Spiranthes spiralis* development is expedited by laboratory conditions and within 18 months after the seeds are sown, four green leaves and a 5 mm long tuber are produced (Wells 1981). Enlarged primary structures develop concurrently with the first seedling leaves. Adventitious buds on the stem of some *Spiranthes* species are capable of vegetative reproduction (Stoutamire 1974). In the greenhouse, *S. cernua* and *S. sinensis* develop from a protocorm to a flowering plant in 35 months and 29 months, respectively (Stoutamire 1974).

Germination and Mycorrhizal Associations: Mycorrhizal penetration into the seed and embryo is required for successful germination of most terrestrial orchid seeds; the seedlings are obligate mycorrhizal dependents until aerial shoots and photosynthesizing apparatuses have developed (Dressler 1981). The abundance of hair-like projections on the non-photosynthesizing protocorms may allow for rapid mycorrhizal association (Stoutamire 1974). Results from laboratory studies suggest a more rapid germination and development period in the early photosynthesizing species than in the late photosynthesizing species, possibly due to a facultative, rather than obligate, relationship of the former species with the fungus (Stoutamire 1974). Most often chlorophyll does not develop for several months even in the early

photosynthesizing species (Dressler 1981). Wells' (1981) results indicate that juvenile orchids remain underground and thus without chlorophyll for greater than one year and maybe as long as fifteen years. As the plant ages, the dependency on fungi is reduced; however, most mature terrestrial orchid roots are associated with endophytic fungi (Warcup 1975, Dressler 1981). Most of the rapidly photosynthesizing protocorm species require sunlight to germinate and often grow in sunny wet areas, characteristic of open marshes and bogs (Stoutamire 1974; Dressler 1981). Whereas germination of most of the non-photosynthesizing protocorm species is inhibited by light, these species grow in well-drained forest soils or open, seasonally dry grasslands (Stoutamire 1974; Dressler 1981). Thus species that grow in cienegas, such as the southern Arizona plants, are presumably early photosynthesizers. Mycorrhizal fungi are required to supply the embryo with needed enzymes and nutrients early in the growth of the seedling; minerals, vitamins and an available organic carbon source are essential to the development of the plant (Stoutamire 1974; Luer 1975; Dressler 1981). The species-specificity of the fungi-orchid symbiosis is ambiguous and is thought to decrease as the plant ages (Warcup 1975). Several different species of fungi are associated with most roots, and taxonomic relationships between fungi and orchid species appear to exist (Warcup 1975; Dressler 1981). Environmental conditions will affect the fungi-orchid relationship; high levels of nitrogen and low soil pH may reduce the likelihood of fungal penetration into the seed, thus decreasing the germination rate (Warcup 1975). The absence of visible growth of an orchid plant does not imply dormancy or death of the plant (Stoutamire 1974). Often orchids grow below-ground for several years without emerging from the soil, receiving nourishment from fungal assimilates (Stoutamire 1974). Some terrestrial orchids have grown saprophytically and remained underground for fifteen years (Sanford 1974). *Spiranthes spiralis* grows saprophytically, solely as a mycorrhizal-rhizome type structure, for eight years before a tuber is produced and a total of eleven years before aerial stems are produced (Wells 1981).

Vegetative Growth and Population Fluctuations: Orchids may grow vegetatively for many years before flowering. *Cypripedium candidum* requires more than twelve years to reach reproductive maturity (Bender 1986) and some *Spiranthes* only bloom every twenty years (B. Jennings, pers. comm. 25 Jan. 1990). Underground structures include tubers, corms, sinkers, roots, and storage roots (Stoutamire 1974). Vegetative propagation occurs through the growth of buds on lateral underground stems, and newly formed plants eventually separate from the parent plant (Wells 1967). Orchids do not produce typical primary roots and most growth occurs in the secondary root system (Stoutamire 1974). The roots of most terrestrial orchids which grow in moist areas occur above the water-line, allowing for the provision of sufficient amounts of oxygen (Dressler 1981). Depending on the species, above-ground vegetative growth may continue year-round or only during the warm growing season. The normally slow growth rate often decreases in the cool season and small over-wintering leaf rosettes may form (B. Jennings, pers. comm. 25 Jan. 1990). *Spiranthes spiralis*, growing in the grasslands of England, are green year-round; leaf rosettes are present when the plants are not in bloom (Wells 1981). In January, a mature plant will contain two mature tubers produced the previous year and a small protuberance, which will develop into the following year's tuber. Plants of this species produce no roots, thus the tuber and fungi are responsible for obtaining the necessary nutrients and water. In July the leaf rosettes die and by August new leaves are formed and a flowering stalk develops (Wells 1981). Stable communities, with a relatively fixed number of mature plants, often have high seedling mortality (Stoutamire 1974). However, terrestrial orchid populations often display great fluctuation within several year periods (Luer 1975). Colonies of many *Spiranthes* species are often labile and above-ground parts may appear and disappear in alternating years (Luer 1975). Population size can alternate from several to hundreds to thousands and back down to several plants in a few years (B. Jennings, pers. comm. 25 Jan. 1990). Plants of *Spiranthes diluvialis* in one location fluctuated from 5500 visible flowering plants in 1986 to 200 plants in 1989, whereas another population, experiencing similar weather conditions and apparently no different management practices, did not have a large flux in population size (B. Jennings, pers. comm. 25 Jan. 1990). One population of *Spiranthes spiralis* went from 420 plants in 1963 to 1050 plants in 1969 (Wells 1981); however, the population size of *Spiranthes spiralis* usually remains relatively constant (Wells 1967). Sheviak (1974) attributes the pronounced changes in population size and

distribution to both climatic fluctuations and edaphic factors which influence the saprophytic/autotrophic state of the orchid. Due to the narrow pH tolerance, specific temperature and moisture requirements of the fungi-orchid association, changes in the environment will lead to altered states of the orchid (Sheviak 1974, B. Jennings, pers. comm. 25 Jan. 1990). In horticultural conditions, *S. cernua* and *S. magnicamporum* can revert from an autotrophic state to a saprophytic state (Sheviak 1974). Some orchids, such as *Triphora trianthophora*, grow underground saprophytically for most of their life and only occasionally produce aerial stems (Sheviak 1974). *Habenaria leucophaea* and some other very rare orchids, may produce hundreds of plants in a location where it was previously rare and then one or two seasons later disappear back to the saprophytic state where it remains for many years (Sheviak 1974). The various negative slopes in the linear survivorship curves (number of plants versus survival years) of different *Spiranthes spiralis* cohorts (same age plants) indicate that the chance of survival is dependent on the year in which the cohorts were produced and is not significantly affected by varying environmental conditions (Wells 1981). The mean expected life for all the cohorts was 53 years and the calculated time until only one plant remained for each cohort ranged from 23 years to 67 years (Wells 1981).

Habitat Comments: Cienegas (mid-elevation wetland communities) at about 1525 m elevation. Soils are highly organic and seasonally or continuously water-saturated, but are not subject to scouring floods. Associated plants are mostly tall grasses, sedges, and rushes. Most members of the genus *Spiranthes* require a moist habitat (B. Jennings, pers. comm. 25 Jan. 1990). *S. graminea* grows abundantly in cienegas (permanently wet meadows in desert foothills) and in the mountains of central Mexico (Luer 1975). *Spiranthes diluvialis*, in Colorado and Utah, grow in flood plains, old stream channels and along streambeds, in densely vegetated open sites and under willow trees (B. Jennings, pers. comm. 25 Jan. 1990). The four populations of *Spiranthes delitescens* occur above a dam in Babocomari Cienega, in marshy meadows, seeps and hummocks along Turkey Creek, in marshy meadows and seeps at O'Donnell Cienega, and on a seeping slope below Sheehy Spring (Sheviak 1990). The dominant vegetation in the cienegas near the *Spiranthes* include grasses, sedges (*Carex* spp.), rushes (*Juncus* spp.), spike-rush (*Eleocharis* spp.), cat-tails (*Typha* spp.), and horsetails (*Equisetum* spp.) (Grater 1973, Merrigan 1990, The Nature Conservancy Arizona Field Office, pers. comm.). Johnson grass (*Sorghum halepense*), a potential threat to the orchid, appears to be spreading into the marshy meadow (McClaran and Sundt 1992). The cienegas are at approximately 1500 m elevation and contain fine grained, highly organic, saturated soils (Merrigan 1990, The Nature Conservancy Arizona Field Office, pers. comm.). The orchid grows in both saturated soil and the surrounding drier sites.

Stewardship Overview: *Spiranthes delitescens* is a newly identified species known from four populations in southern Arizona; it is distinct from *Spiranthes graminea*. The population at one site, ranging from hundreds to thousands of plants, appears healthier and more vigorous than another one. Possibly the greatest threat to the survivability and fecundity of the orchid is the dense vegetation surrounding the small orchid plants. Possible effective management practices such as grazing, fires, and control of competing native and non-native plants have not been researched enough to determine the best practice or the best combination of practices. Due to the possible fluctuation in population size resulting from the reversion from a partially autotrophic plant back to a saprophytic plant, a characteristic common to many *Spiranthes* species, the status of these plants cannot be determined. Extensive research on the life-cycle and environmental requirements of this species is required before management plans should be discussed; burning experiments are being planned for one population.

Restoration Potential: Recovery of the *Spiranthes* is dependent on determining the optimum habitat conditions required for successful flowering, fruiting, germination, and maturation. Most probably this will relate to reduction in the density of the vegetation cover of the marsh. A prescribed burn at one protected site in 1991 failed to increase orchid numbers that year. But because saprophytic individuals in other *Spiranthes* species take at least one year to revert to aboveground plants and because germinated seeds must spend one to twelve years as obligate

saprophytes, the response of the population to the prescribed burn is not known at this time. Therefore, until the ecological requirements are known and optimal conditions can be produced through management actions, we can only speculate as to the recovery potential of the populations.

Management Requirements: Discussions on Natural Occurrence and Management Implications of Fire and Grazing at Two Sites and the Response of Orchids to Habitat Alterations: Heitlinger (pers. comm. 8 Jan. 1990) and McClaran (pers. comm. 24 Jan. 1990) feel that historically fires occurred naturally in the cienegas when lightning-caused fires in the uplands spread down into the marshes and burned at cool temperatures. Suppression activities and roads are factors resulting in the reduction of the spread of natural fires. Most likely the fires would have occurred in the late spring (April through June) before moist, green vegetation developed (Merrigan 1990). In this case, fires would have periodically removed the dense vegetation surrounding the orchids prior to maximum orchid growth. However, Gehlbach (1986) and Sundt (pers. comm. 23 Jan. 1990) feel that little evidence exists to support the assumption that fires frequently swept through the marshes; they believe the wet marsh would not support fires. Perhaps fire was restricted to drought years or occurrences of winter lightning storms. The possibility of burning having a detrimental effect on the orchid does exist if the fire occurs during a crucial growth phase or if the fleshy surface tubers are damaged by fire (P. Sundt, pers. comm. 23 Jan. 1990; The Nature Conservancy Arizona Field Office, pers. comm.). Controlled burning maintains the appropriate habitat for some orchid species (Dressler 1981). Some species in South Africa and Australia flower only after fires, some flower more prolifically without fire, and the flowering of some other species is unaffected by fire (Dressler 1981). Several prairie orchids, such as *Spiranthes cernua*, sand-prairie ecotype, and *Spiranthes lacera*, appear to increase the number of flowering plants after burns (conditions of the burns were not indicated); possibly, fire physiologically triggers the bloom stage (Sheviak 1974; Sanford 1974; B. Jennings, pers. comm. 25 Jan. 1990). Orchids with protected underground buds tend to benefit (increase in number of flowering plants) or be unaffected by fires, whereas species with surface pseudobulbs require protective rocky spots in order to survive fires (Sanford 1974). Most likely, the timing of a fire is extremely critical. A burn at one site conducted in April 1979 resulted in the increase in orchid number from 40 to 196 in August following the fire (McClaran and Sundt 1992; The Nature Conservancy Arizona Field Office, pers. comm.). However, the number of plants growing in unburned locations also increased during this period, so possibly other environmental conditions were responsible for the significant increase in number of orchid plants (McClaran and Sundt 1992; The Nature Conservancy Arizona Field Office, pers. comm.). A fire conducted in May 1986 resulted in a decrease in population size from 97 (flags, presumably indicating orchids from the previous year) to 8 plants (McClaran and Sundt 1992; The Nature Conservancy Arizona Field Office, pers. comm.). The difference in the effect of the second fire compared to the 1979 fire may be due to the more advanced, vulnerable growth stage of the orchid in May. These results indicate the importance of determining the most beneficial time of burning. The effects of high fuel loads and temperature of burns in the cienega should be determined in order to prevent damage to the tuber by hot fires. Gehlbach (1986) emphasizes the importance of grazing on marsh vegetation. Over the past 10,000 years periodic exposure of southern Arizona cienegas to mammoths, Spanish cattle and Anglo livestock have resulted in trampling and grazing. Gehlbach (pers. comm. 25 Feb. 1990) feels that short durations of heavy grazing, analogous to the conditions of migratory animals, may be a natural and efficient means of managing the cienega. Livestock possibly aids in the survival of the orchid by tilling the soil, providing appropriate microsites for seedling establishment, and decreasing the litter accumulation. McClaran and Sundt (1992) suggest that grazing at one site and the exclusion of grazing at another site may explain the more abundant orchid plants at the former location. *Spiranthes* at the first site grow in a more open and less crowded vegetative (not necessarily more natural) setting than those at the second site (P. Sundt, pers. comm. 23 Jan. 1990). Possibly, cattle grazing may aid in the orchid growth by reducing the competition of neighboring grasses for space and nutrients (Fernald 1987). However, the populations at both of these sites are both described as decreasing in the number of flowering plants over the past ten years (M. McClaran, pers. comm. 24 Jan. 1990), thus damaging the argument of the effectiveness of grazing. Due to the absence of grazers for

thousands of years, between the period of mammoths and cattle, Heitlinger (pers. comm. 8 Jan. 1990) feels that a non-grazing disturbance was most likely associated with the recent evolution of this orchid. Management experiments on *Spiranthes spiralis* indicate that grazing by rabbits cleared the vegetation and provided sites for seed germination eleven years prior to the study. This is evident by the increase in number of autotrophic seedlings of a species that requires eleven years of saprophytic development prior to emergence (Wells 1981). This experiment suggests the long-term time span required to assess the response of a *Spiranthes* species to a particular management technique. The rare orchid *Spiranthes magnicamporum* increases significantly in lightly grazed areas, but apparently the benefit from grazing is not due to increases in light level; the optimum grazing level is so low that there is no significant reduction in vegetation (Sheviak 1974). Casual observations indicate a high concentration of several *Spiranthes* species in grazed areas. The rare *S. parksii*, which grows in open, grassy woodland sites in Texas, is most abundant in areas exposed to heavy cattle grazing; the *S. romanzoffiana* growing in Alaska is especially abundant along moose trails: Gehlbach (pers. comm. 25 Feb. 1990) suggests the possiblity of the hoof-turned soil benefitting the establishment and/or survival of the plants. Higher concentrations of *S. cernua* and *S. gracilis* are found growing beside horse trails than in areas distant from horse trails; the plants occur close to the trail where the effects of the hooves are present, but far enough from the trail to be out of reach of the grazers (F. Gehlbach, pers. comm. 25 Feb. 1990). Detrimental effects of grazing are illustrated by the apparent (but not confirmed) extirpation of a population of *Spiranthes diluvialis* plants in Utah in a heavily grazed field (Sheviak 1984). The species may have a number of additional management needs although the research needed to identify these needs has not be completed. These needs include: (1) maintenance of the hydrologic regime; (2) control of exotics like Johnson grass; and (3) reduction of accumulated litter to increase light and water availability to orchids. Maintenance of the hydrologic regime may require the retirement or reduction of grazing in the watershed to (i) stabilize spring flows and (ii) reduce the probability of a scouring flood and channel erosion, thus ensuring that water table depths remain near the surface. Flooding of marshy species has most likely resulted in the apparent decline or extirpation of *Spiranthes* populations in southern Arizona and Utah (Sheviak 1984, McClaran and Sundt 1992). However, Gehlbach (pers. comm. 25 Feb. 1990) speculates on a beneficial scheme of periodic flash floods playing a historical role in restoring favorable conditions for the orchid by removing the dense vegetation cover. Control of exotic species like Johnson grass can be accomplished by (i) frequent mowing in areas that are completely dominated by Johnson grass and too dry to support *Spiranthes* and (ii) hand-application of herbicides to weeds in areas that are dominated by native species. Many orchid species cannot compete with fast growing, large herbaceous plants. The population size of *Spiranthes spiralis* growing in areas where land is frequently disturbed (mowed, plowed, etc.) decreases when tall grasses or dense short grasses increase in abundance (Sanford 1974). *Spiranthes ovalis* is a rare plant under undisturbed conditions; however, it readily invades areas that have been altered, particularly abandoned wooded pastures and old fields (Sheviak 1974). *Cypripedium candidum* and *Spiranthes lacera* thrive in sites where annual mowing occurs (Curtis 1946; Sheviak 1974). A recovery in the number of Cypripedium candidum plants was seen within five years of initiation of mowing practices which reduced the amount of shrubs (Curtis 1946). In mowed sites, flowering of *Spiranthes lacera* is directly dependent (the dependency was not explained) on the clipping regime (Sheviak 1974). Reduction of accummulated litter can be accomplished by prescribed burning, grazing, mowing, or clipping. Disagreement over the most natural management regime for the *Spiranthes* exists, with several individuals suggesting burning (M. Heitlinger, pers. comm. 8 Jan. 1990; P. Warren, pers. comm. 25 Jan. 1990) and others recommending grazing (Gehlbach 1986; P. Sundt, pers. comm. 23 Jan. 1990). Manipulations which alter the soil characteristics should be avoided in the fall when the seeds are most likely beginning to germinate and commence the mycorrhizal relationship; in many orchid species the initial orchid-fungi association is extremely precarious (Wells 1981). More information on the orchid's life-cycle and environmental requirements and experimentation on the effect of different management practices (grazing, fire, mowing, clipping) are needed to identify the most effective management procedures.

Monitoring Requirements: Monitoring *Spiranthes delitescens* at all known sites is needed to assess the current status of the species. T here is some background information on population numbers of aboveground plants at two well-studied sites. Both populations appear to be declining; the declines have been most dramatic at one site. There are no estimates of population size for the other two populations which are known only from collection records. Monitoring can also be used to understand the developmental processes and ecological requirements of this species, thereby increasing our ability to accurately forecast and interpret population fluctuations. A permanent marking system should be employed, allowing for continual monitoring of individual plants. The position of each plant should be labelled with respect to the perimeter of the specific plot in which the plant is contained. Labelled stakes, indicating the precise location, should be placed consistently on one side (i.e. due north) of each plant. McClaran and Sundt (1992) use a 1 m X 1 m square placed over permanent corner stakes to mark the plot boundary, and each plant is labelled with both the distance to each stake and the direction (E or W) relative to the line connecting the two stakes. Yearly vegetative and floral measurements should be taken consistently in August, during the period of flower and fruit development. Measurements on each individual plant should include presence or absence of vegetative and floral growth, height of shoot and inflorescence and number of flowers and fruits. The percentage of mature fruits which contain seeds is valuable information, since some *Spiranthes* species develop fruit without producing seeds (Catling 1982). Along with the yearly detailed monitoring, visual observations of the vegetative conditions (presence or absence of leaf rosettes) throughout the year should be noted. The environmental requirements for germination, growth, survivorship and reproduction are unknown for *Spiranthes delitescens*. If research indicates that one or more of the following environmental parameters are important, then this parameter(s) should also be monitored on a monthly or biweekly basis throughout the growing season. Potentially important environmental parameters may include: soil temperature, moisture, pH, light intensity at soil level and 10 cm above the soil level (orchid leaf level), and precipitation. Possibly, complete soil analyses should be performed periodically in order to determine differences in mineral availability and microorganism diversity at the various sites.

Management Programs: Burning experiments are being planned for one protected site. The study site will be divided into thirds and the three treatments will include a control, burns conducted every two years and every seven years. Contact: Mark Heitlinger, Director of Stewardship, The Nature Conservancy, Arizona Field Office, Tucson, Arizona.

Monitoring Programs: Several monitoring programs are currently underway at one protected site.

Contacts: Peter Warren/Dave Gori, The Nature Conservancy, Arizona Field Office, Tucson, Arizona 85705; (602) 622-3861. The monitoring plan for *Spiranthes* includes counts of vegetative and reproductive individuals in eleven experimental plots that were randomly assigned one of three prescribed burn treatments. Dave Gori has received funds from The Nature Conservancy to develop a monitoring plan for *S. delitescens* in 1992.

Mitchel McClaran and Peter Sundt, Department of Range Management, University of Arizona, Tucson, Arizona 85721; (602) 621-1673. Vegetative and floral parameters of the *Spiranthes* have been monitored by various people from 1978 to 1989 (McClaran and Sundt 1992).

Judy Davis, Department of Hydrology, University of Arizona, Tucson, Arizona 85721; (602) 621-1723. Monitoring of several hydrological features at the cienega have been conducted from 1988 to 1990 (J. Davis, pers. comm. 29 Jan. 1990).

Spiranthes spiralis was monitored from 1963 until 1980 at the following location: Knocking Hoe National Nature Reserve, Bedfordshire, England (Wells 1981).

Management Research Programs: The Nature Conservancy is now conducting a long-term study to assess the effect of prescribed burns and burn frequency on the structure and

composition of cienega vegetation and *Spiranthes*. For more information about this study, contact: Dave Gori, The Nature Conservancy, 300 E. University Blvd., #230, Tucson, Arizona 85705; (602) 622-3861.

Cytological and morphological studies have been performed by: Charles Sheviak, Botanist, New York State Museum, Albany, New York.

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BIOLOGICAL SURVEY
ATTACHMENT B

(b) (7)(E) STATION WILDLIFE SPECIES LISTS

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
BIRDS				
Blackbirds, Orioles				
Emberizidae				
Agelaius phoeniceus	Red-winged blackbird	G5/S5	---	---
Dolichonyx oryzivorus	Bobolink	G5/S1	---	---
Euphagus cyanocephalus	Brewer's blackbird	G5/S5	---	---
Icterus bullockii	Bullock's oriole	G5/SNRB	---	---
Icterus cucullatus	Hooded oriole	G5/S5	---	---
Icterus parisorum	Scott's oriole	G5/S5	---	---
Molothrus aeneus	Bronzed cowbird	G5/S5	---	---
Molothrus ater	Brown-headed cowbird	G5/S5	---	---
Quiscalus mexicanus	Great-tailed grackle	G5/S5	---	---
Sturnella magna	Eastern meadowlark	G5/S5	---	---
Sturnella neglecta	Western meadowlark	G5/S5	---	---
Xanthocephalus xanthocephalus	Yellow-headed blackbird	G5/S5	---	---
Bushtits				
Aegithalidae				
Psaltriparus minimus	Bushtit	G5/S5	---	---
Caracaras, Falcons				
Falconidae				
Caracara cheriway	Crested caracara	G5/S1S2	---	---
Falco columbarius	Merlin	G5/S4N	---	---
Falco mexicanus	Prairie falcon	G5/S4	---	---
Falco peregrinus	Peregrine falcon	G4T4/S4	SC	WSC
Falco sparverius	American kestrel	G5/S5	---	---
Cormorants				
Phalacrocoracidae				
Phalacrocorax auritus	Double-crested cormorant	G5/S5	---	---
Phalacrocorax brasilianus	Neotropic cormorant	G5/S1N	---	---
Cranes				
Gruidae				
Grus canadensis	Sandhill crane	G5/S3N	---	---
Crows and Jays				
Corvidae				
Aphelocoma californica	Western scrub jay	G5/S5	---	---
Corvus corax	Common raven	G5/S5	---	---
Corvus cryptoleucus	Chihuahuan raven	G5/S4	---	---
Cyanocitta stelleri	Steller's jay	G5/S5	---	---
Cuckoos				
Cuculidae				
Coccyzus americanus	Yellow-billed cuckoo	G3T3Q/S3	C	WSC

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
BIRDS (continued)				
Geococcyx californianus	Greater roadrunner	G5/S5	---	---
Doves				
Columbidae				
Columbina inca	Inca dove	G5/S5	---	---
Columbina passerina	Common ground-dove	G5/S4	---	---
Columbina talpacote	Ruddy ground-dove	G5/S1B,S2N	---	---
Zenaida asiatica	White-winged dove	G5/S5	---	---
Zenaida macroura	Mourning dove	G5/S5	---	---
Ducks, Geese, Swans				
Anatidae				
Aix sponsa	Wood duck	G5/S2B,S3N	---	---
Anas acuta	Northern pintail	G5/S2B,S5N	---	---
Anas americana	American wigeon	G5/S1B,S5N	---	---
Anas clypeata	Northern shoveler	G5/S1B,S5N	---	---
Anas crecca	Green-winged teal	G5/S3B,S5N	---	---
Anas cyanoptera	Cinnamon teal	G5/S5	---	---
Anas discors	Blue-winged teal	G5/S2B,S5N	---	---
Anas penelope	Eurasian wigeon	G5/S2N	---	---
Anas platyrhynchos	Mallard	G5/S5	---	---
Anas strepera	Gadwall	G5/S5	---	---
Anser albifrons	Greater white-fronted goose	G5/S2N	---	---
Aythya affinis	Lesser scaup	G5/S5N	---	---
Aythya americana	Redhead	G5/S4	---	---
Aythya collaris	Ring-necked duck	G5/S5	---	---
Aythya valisneria	Canvasback	G5/S1B,S4N	---	---
Branta canadensis	Canada goose	G5/S1B,S4N	---	---
Bucephala albeola	Bufflehead	G5/S5N	---	---
Chen caerulescens	Snow goose	G5/S3N	---	---
Cygnus columbianus	Tundra swan	G5/S1N	---	---
Dendrocygna autumnalis	Black-bellied whistling-duck	G5/S3	---	WSC
Dendrocygna bicolor	Fulvous whistling-duck	G5/?	---	---
Lophodytes cucullatus	Hooded merganser	G5/S2N	---	---
Mergus merganser	Common merganser	G5/S3S4	---	---
Oxyura jamaicensis	Ruddy duck	G5/S5	---	---
Finches				
Fringillidae				
Carduelis lawrencei	Lawrence's goldfinch	G3G4/S1,S3N	---	---
Carduelis pinus	Pine siskin	G5/S5	---	---
Carduelis psaltria	Lesser goldfinch	G5/S5	---	---
Carduelis tristis	American goldfinch	G5/S1B,S5N	---	---
Carpodacus cassinii	Cassin's finch	G5/S4	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
BIRDS (continued)				
Carpodacus mexicanus	House finch	G5/S5	---	---
Carpodacus purpureus	Purple finch	G5/S1,S2N	---	---
Gnatcatchers				
Muscicapidae				
Polioptila caerulea	Blue-gray gnatcatcher	G5/S5	---	---
Polioptila melanura	Black-tailed gnatcatcher	G5/S5	---	---
Goatsuckers				
Caprimulgidae				
Chordeiles acutipennis	Lesser nighthawk	G5/S5	---	---
Phalaenoptilus nuttallii	Common poorwill	G5/S5	---	---
Grebes				
Podicipedidae				
Aechmophorus occidentalis	Western grebe	G5/S3	---	---
Podiceps nigricollis	Eared grebe	G5/S3B,S5N	---	---
Podilymbus podiceps	Pied-billed grebe	G5/S5	---	---
Grosbeaks and Buntings				
Emberizidae				
Cardinalis cardinalis	Northern cardinal	G5/S5	---	---
Cardinalis sinuatus	Pyrrhuloxia	G5/S5	---	---
Guiraca caerulea	Blue grosbeak	G5/S5	---	---
Passerina amoena	Lazuli bunting	G5/S4	---	---
Passerina ciris	Painted bunting	G5/S2,S3M	---	---
Passerina cyanea	Indigo bunting	G5/S3	---	---
Passerina versicolor	Varied bunting	G5/S3	---	---
Pheucticus ludovicianus	Rose-breasted grosbeak	G5/S3N	---	---
Pheucticus melanocephalus	Black-headed grosbeak	G5/S5	---	---
Spiza americana	Dickcissel	G5/S2M	---	---
Gulls, Terns				
Laridae				
Chlidonias niger	Black tern	G4/S3,S4M	---	---
Larus delawarensis	Ring-billed gull	G5/S5N	---	---
Larus philadelphia	Bonaparte's gull	G5/S3,S4M	---	---
Sterna forsteri	Forster's tern	G5/S2N	---	---
Hawks, Kites, Eagles				
Accipitridae				
Accipiter cooperi	Cooper's hawk	G5/S4	---	---
Accipiter striatus	Sharp-shinned hawk	G5/S4	---	---
Aquila chrysaetos	Golden eagle	G5/S4	---	---
Buteo albonotatus	Zone-tailed hawk	G4/S4	---	---
Buteo jamaicensis	Red-tailed hawk	G5/S5	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Buteo lagopus	Rough-legged hawk	G5/SNRN	---	---
BIRDS (continued)				
Buteo nitidus	Gray hawk	G5T4Q/S3	SC	WSC
Buteo regalis	Ferruginous hawk	G5/S3	---	---
Buteo swainsoni	Swainson's hawk	G5/S3	---	---
Buteogallis anthracinus	Common black-hawk	G4G5/S3	---	WSC
Circus cyaneus	Northern harrier	G5/S1S2B,S5N	---	---
Elanus leucurus	White-tailed kite	G5/S2B,S2S3N	---	---
Haliaeetus leucocephalus	Bald eagle	G5/S4N	LT,PDL	WSC
Ictinia mississippiensis	Mississippi kite	G5/S3	---	WSC
Pandion haliaetus	Osprey	G5/S2B,S4N	---	---
Parabuteo unicinctus	Harris's hawk	G5/S5	---	---
Herons, Bitterns, Allies				
Ardeidae				
Ardea herodias	Great blue heron	G5/S5	---	---
Botaurus lentiginosus	American bittern	G4/S1S2	---	---
Bubulcus ibis	Cattle egret	G5/S1B, S4N	---	---
Butorides striatus	Green-backed heron	G5/S4	---	---
Casmerodius albus	Great egret	G5/S1B,S4N	---	---
Egretta caerulea	Little blue heron	G5/S1S2N	---	---
Egretta thula	Snowy egret	G5/S1B,S4N	---	---
Ixobrychus exilis	Least bittern	G5/S3	---	---
Nycticorax nycticorax	Black-crowned night-heron	G5/S3	---	---
Nycticorax violaceus	Yellow-crowned night-heron	G5/?	---	---
Hummingbirds				
Trochilidae				
Archilochus alexandri	Black-chinned hummingbird	G5/S5	---	---
Calypte anna	Anna's hummingbird	G5/S5	---	---
Calypte costae	Costa's hummingbird	G5/S5	---	---
Cynanthus latirostris	Broad-billed hummingbird	G4/S3	---	---
Eugenes fulgens	Magnificent hummingbird	G5/S4	---	---
Selasphorus platycercus	Broad-tailed hummingbird	G5/S5	---	---
Selasphorus rufus	Rufous hummingbird	G5/S5M	---	---
Stellula calliope	Calliope hummingbird	G5/S4M	---	---
Ibises				
Threskiornithidae				
Eudocimus albus	White ibis	G5/?	---	---
Plegadis chihi	White-faced ibis	G5/S?B,S2S3N	SC	---
Kingfishers				

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Alcedinidae				
BIRDS (continued)				
Ceryle alcyon	Belted kingfisher	G5/S2B,S5N	---	---
Chloroceryle americana	Green kingfisher	G5/S2	---	---
Kinglets and Thrushes				
Muscicapidae				
Catharus guttatus	Hermit thrush	G5/S5	---	---
Regulus calendula	Ruby-crowned kinglet	G5/S5	---	---
Sialia mexicana	Western bluebird	G5/S5	---	---
Turdus migratorius	American robin	G5/S5	---	---
Larks				
Alaudidae				
Eremophila alpestris	Horned lark	G5/S5	---	---
Loons				
Gaviidae				
Gavia immer	Common loon	G5/S2N	---	---
Mockingbirds and Thrashers				
Mimidae				
Dumetella carolinensis	Gray catbird	G5/S1	---	---
Mimus polyglottos	Northern mockingbird	G5/S5	---	---
Oreoscoptes montanus	Sage thrasher	G5/S5	---	---
Toxostoma bendirei	Bendire's thrasher	G4G5/S4	---	---
Toxostoma curvirostre	Curve-billed thrasher	G5/S5	---	---
Toxostoma dorsale	Crissal thrasher	G5/S5	---	---
Toxostoma rufum	Brown thrasher	G5/S1N	---	---
Nuthatches				
Sittidae				
Sitta carolinensis	White-breasted nuthatch	G5/S5	---	---
Owls				
Strigidae				
Asio otus	Long-eared owl	G5/S2B,S3S4N	---	---
Athene cunicularia	Burrowing owl	G4T4/S3	SC	---
Bubo virginianus	Great horned owl	G5/S5	---	---
Micrathene whitneyi	Elf owl	G5/S5	---	---
Otus kennicottii	Western screech owl	G4/S4	---	---
Tytonidae				
Tyto alba	Common barn owl	G5TNR/?	---	---
Pelicans				
Pelicanidae				
Pelecanus occidentalis	Brown pelican	G4/S1N	---	---
Pipits				
Motacillidae				
Anthus rubescens	American pipit	G5/S2B,S5N	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
BIRDS (continued)				
Plovers				
Charadriidae				
Charadrius vociferus	Killdeer	G5/S5	---	---
Quail, New World				
Phasianidae				
Callipepla gambelii	Gambel's quail	G5/S5	---	---
Callipepla squamata	Scaled quail	G5/S5	---	---
Cyrtonyx montezumae	Montezuma quail	G4G5/S4	---	---
Rails, Gallinules, Coots				
Rallidae				
Fulica americana	American coot	G5/S5	---	---
Gallinula chloropus	Common moorhen	G5/S5	---	---
Porzana carolina	Sora	G5/S4	---	---
Rallus limicola	Virginia rail	G5/S4	---	---
Sandpipers, Phalaropes				
Scolopacidae				
Actitis macularius	Spotted sandpiper	G5/S3S4	---	---
Calidris bairdii	Baird's sandpiper	G5/S4M	---	---
Calidris mauri	Western sandpiper	G5/S1N	---	---
Calidris minutilla	Least sandpiper	G5/S5N	---	---
Calidris pusilla	Semipalmated sandpiper	G5/S2M	---	---
Catoptrophorus semipalmatus	Willet	G5/S4M	---	---
Gallinago delicata	Wilson's snipe	G5/S1B,S4N	---	---
Limnodromus scolopaceus	Long-billed dowitcher	G5/S3S4N	---	---
Numenius americana	Long-billed curlew	G5/S1B,S3S4N	---	---
Phalaropus tricolor	Wilson's phalarope	G5/S1B,S5N	---	---
Tringa flavipes	Lesser yellowlegs	G5/S4M	---	---
Tringa melanoleuca	Greater yellowlegs	G5/S3N	---	---
Tringa solitaria	Solitary sandpiper	G5/S3M	---	---
Shrikes				
Laniidae				
Lanius ludovicianus	Loggerhead shrike	G4/S4	---	---
Silky Flycatchers				
Ptilogonatidae				
Phainopepla nitens	Phainopepla	G5/S5	---	---
Sparrows, New World				
Emberizidae				
Aimophila botterii	Botteri's sparrow	G4/S4	---	---
Aimophila cassinii	Cassin's sparrow	G5/S4	---	---
Aimophila ruficeps	Rufous-crowned sparrow	G5/S4	---	---
Ammodramus savannarum	Grasshopper sparrow	G5/S3	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
BIRDS (continued)				
Amphispiza belli	Sage sparrow	G5/S4	---	---
Amphispiza bilineata	Black-throated sparrow	G5/S5	---	---
Calamospiza melanocorys	Lark bunting	G5/S1B,S5N	---	---
Calcarius ornatus	Chestnut-collared longspur	G5/S3N	---	---
Chondestes grammacus	Lark sparrow	G5/S5	---	---
Junco hyemalis	Dark-eyed junco	G5/S5		
Melospiza georgiana	Swamp sparrow	G5/S2S3N	---	---
Melospiza lincolnii	Lincoln's sparrow	G5/S3B,S5N	---	---
Melospiza melodia	Song sparrow	G5/S5	---	---
Passerculus sandwichensis	Savannah sparrow	G5/S5	---	---
Pipilo chlorurus	Green-tailed towhee	G5/S3B,S4N	---	---
Pipilo fuscus	Canyon towhee	G5/S5	---	---
Pipilo maculatus	Spotted towhee	G5/S5	---	---
Pooecetes gramineus	Vesper sparrow	G5/S5	---	---
Spizella atrogularis	Black-chinned sparrow	G5/S5	---	---
Spizella breweri	Brewer's sparrow	G5/S5	---	---
Spizella passerina	Chipping sparrow	G5/S5	---	---
Zonotrichia albicollis	White-throated sparrow	G5/S2S3N	---	---
Zonotrichia atricapilla	Golden-crowned sparrow	G5/S1S2N	---	---
Zonotrichia leucophrys	White-crowned sparrow	G5/S1B,S5N	---	---
Sparrows, Old World				
Passeridae				
Passer domesticus	House sparrow	G5/SNA	---	---
Starlings				
Sturnidae				
Sturnus vulgaris	European starling	G5/SNA	---	---
Stilts, Avocets				
Recurvirostridae				
Himantopus mexicanus	Black-necked stilt	G5/S2	---	---
Recurvirostra americana	American avocet	G5/S2	---	---
Storks				
Ciconiidae				
Mycteria americana	Wood stork	G4/S1N	---	---
Swallows				
Hirundinidae				
Hirundo pyrrhonota	Cliff swallow	G5/S5	---	---
Hirundo rustica	Barn swallow	G5/S5	---	---
Progne subis	Purple martin	G5/S4	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Riparia riparia	Bank swallow	G5/S4M	---	---
BIRDS (continued)				
Stelgidopteryx serripennis	Northern rough-winged swallow	G5/S5	---	---
Tachycineta bicolor	Tree swallow	G5/S3	---	---
Tachycineta thalassina	Violet-green swallow	G5/S5	---	---
Swifts				
Apodidae				
Aeronautes saxatilis	White-throated swift	G5/S5	---	---
Chaetura vauxi	Vaux's swift	G5/S4M	---	---
Tanagers				
Emberizidae				
Piranga ludoviciana	Western tanager	G5/S5	---	---
Piranga rubra	Summer tanager	G5/S4	---	---
Titmice				
Paridae				
Parus wollweberi	Bridled titmouse	G5/S4	---	---
Turkeys				
Galliformes				
Meleagris gallopavo	Wild turkey	G5/S5	---	---
Tyrant Flycatchers				
Tyrannidae				
Campostoma imberbe	Northern beardless-tyrannulet	G5/S4	---	---
Contopus cooperi	Olive-sided flycatcher	G4/S4	---	---
Contopus sordidulus	Western wood-peewee	G5/S5	---	---
Emidonax hammondii	Hammond's flycatcher	G5/S1B,S2S3N	---	---
Empidonax oberholseri	Dusky flycatcher	G5/S4	---	---
Empidonax occidentalis	Cordilleran flycatcher	G5/S2S3B	---	---
Empidonax traillii	Willow flycatcher	G5/S1	---	---
Empidonax wrightii	Gray flycatcher	G5/S5	---	---
Myiarchus cinerascens	Ash-throated flycatcher	G5/S5	---	---
Myiarchus tuberculifer	Dusky-capped flycatcher	G5/S4	---	---
Myiarchus tyrannulus	Brown-crested flycatcher	G5/S4	---	---
Myiodynastes luteiventris	Sulphur-bellied flycatcher	G5/S3	---	---
Pachyramphus aglaiae	Rose-throated becard	G4G5/S1	---	---
Pyrocephalus rubinus	Vermilion flycatcher	G5/S5	---	---
Sayornis nigricans	Black phoebe	G5/S5	---	---
Sayornis phoebe	Eastern phoebe	G5/S1N	---	---
Sayornis saya	Say's phoebe	G5/S5	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Tyrannus crassirostris	Thick-billed kingbird	G5/S2	---	WSC
Tyrannus melancholicus	Tropical kingbird	G5/S3	---	WSC
BIRDS (continued)				
Tyrannus verticalis	Western kingbird	G5/S5	---	---
Tyrannus vociferans	Cassin's kingbird	G5/S5	---	---
Verdins				
Remizidae				
Auriparus flaviceps	Verdin	G5/S5	---	---
Vireos				
Vireonidae				
Vireo bellii	Bell's vireo	G5/S4	---	---
Vireo gilvus	Warbling vireo	G5/S5	---	---
Vireo huttoni	Hutton's vireo	G5/S5	---	---
Vireo plumbeus	Plumbeous vireo	G5/S5	---	---
Vireo solitarius	Blue-headed vireo	G5/?	---	---
Vultures, New World				
Cathartidae				
Cathartes aura	Turkey vulture	G5/S5	---	---
Coragyps atratus	Black vulture	G5/S1S2	---	---
Waxwings				
Bombycillidae				
Bombycilla cedrorum	Cedar waxwing	G5/S3S4N	---	---
Woodpeckers				
Picidae				
Colaptes auratus	Northern flicker	G5/S5	---	---
Colaptes chrysoides	Gilded flicker	G5/S5	---	---
Melanerpes lewis	Lewis's woodpecker	G4/S4	---	---
Melanerpes uropygialis	Gila woodpecker	G5/S5	---	---
Picoides scalaris	Ladder-backed woodpecker	G5/S5	---	---
Sphyrapicus nuchalis	Red-naped sapsucker	G5/S4	---	---
Wood Warblers				
Emberizidae				
Dendroica caerulescens	Black-throated blue warbler	G5/S1M	---	---
Dendroica coronata	Yellow-rumped warbler	G5/S5	---	---
Dendroica nigrescens	Black-throated gray warbler	G5/S5	---	---
Dendroica occidentalis	Hermit warbler	G4G5/S4M	---	---
Dendroica petechia	Yellow warbler	G5/S4	---	---
Dendroica townsendii	Townsend's warbler	G5/S4M,S1S2N	---	---
Geothlypis trichas	Common yellowthroat	G5/S4	---	---
Icteria virens	Yellow-breasted chat	G5/S4	---	---
Myioborus pictus	Painted redstart	G5/S4	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Oporornis formosus	Kentucky warbler	G5/S1M	---	---
Oporornis tolmiei	MacGillivray's warbler	G5/S4	---	---
Seiurus noveboracensis	Northern waterthrush	G5/S2S3M	---	---
Setophaga ruticilla	American redstart	G5/S1	---	---
Vermivora celata	Orange-crowned warbler	G5/S3B,S5N	---	---
Vermivora luciae	Lucy's warbler	G5/S5	---	---
Vermivora ruficapilla	Nashville warbler	G5/S4S5M	---	---
Vermivora virginiae	Virginia's warbler	G5/S5	---	---
Wilsonia pusilla	Wilson's warbler	G5/S5M	---	---
Wrens				
Troglodytidae				
Campylorhynchus brunneicapillus	Cactus wren	G5/S5	---	---
Cistothorus palustris	Marsh wren	G5/S2B,S3S4N	---	---
Salpinctes obsoletus	Rock wren	G5/S5	---	---
Thryomanes bewickii	Bewick's wren	G5/S5	---	---
Troglodytes aedon	House wren	G5/S5	---	---
MAMMALS				
Badgers and Skunks				
Mephitidae				
Mephitis mephitis	Striped skunk	G5/S5	---	---
Spilogale gracilis	Western spotted skunk	G5/S5	---	---
Bats, Free-tailed				
Molossidae				
Nyctinomops macrotis	Big free-tailed bat	G5/S2S3	---	---
Tadarida brasiliensis	Brazilian free-tailed bat	G5/S3S4	---	---
Bats, Leaf-nose				
Phyllostomidae				
Leptonycteris curasoae	Lesser long-nosed bat	G4/S2	LE	WSC
Bats, Plain-nose				
Vespertilionidae				
Antrozous pallidus	Pallid bat	G5/S4S5	---	---
Eptesicus fuscus	Big brown bat	G5/S4S5	---	---
Lasiurus blossevillei	Western red bat	G5/S2	---	WSC
Lasiurus cinereus	Hoary bat	G5/S4	---	---
Lasiurus xanthinus	Western yellow bat	G5/S1	---	WSC
Myotis auriculus	Southwestern myotis	G5/S3	---	---
Myotis californicus	California myotis	G5/S4S5	---	---
Myotis thysanodes	Fringed myotis	G4G5/S3S4	SC	---
Myotis velifer	Cave myotis	G5/S4	SC	---
Pipistrellus hesperus	Western pipistrelle	G5/S5	---	---
Plecotus townsendii	Townsend's big-eared bat	G4/S3S4	---	---

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Badgers				
Mustelidae				
Taxidea taxus	American badger	G5/S5	---	---
MAMMALS (continued)				
Bears				
Ursidae				
Ursus americanus	Black bear	G5/S5	---	---
Cats				
Felidae				
Lynx rufus	Bobcat	G5/S5	---	---
Puma concolor	Mountain lion	G5/S4	---	---
Coyotes and Foxes				
Canidae				
Canis latrans	Coyote	G5/S5	---	---
Urocyon cineroargenteus	Gray fox	G5/S5	---	---
Deer				
Cervidae				
Odocoileus hemionus	Mule deer	G5/S5	---	---
Odocoileus virginianus	White-tailed deer	G5/S5	---	---
Javelina				
Tayassuidae				
Pecari tajacu	Collared peccary	G5/S5	---	---
Pocket Gophers				
Geomyidae				
Thomomys bottae	Botta's pocket gopher	G5/S5	---	---
Thomomys umbrinus	Southern pocket gopher	G5/S4	---	---
Pocket Mice and Kangaroo Rats				
Heteromyidae				
Chaetodipus baileyi	Bailey pocket mouse	G5/S5	---	---
Chaetodipus hispidus	Hispid pocket mouse	G5/S5	---	---
Chaetodipus penicillatus	Desert pocket mouse	G5/S5	---	---
Dipodomys merriami	Merriam's kangaroo rat	G5/S5	---	---
Dipodomys ordii	Ord's kangaroo rat	G5/S5	---	---
Dipodomys spectabilis	Banner-tailed kangaroo rat	G5/S5	---	---
Perognathus flavus	Silky pocket mouse	G5/S5	---	---
Porcupines				
Erethizontidae				
Erethizon dorsatum	Porcupine	G5/S4S5	---	---
Rabbits and Hares				
Leporidae				
Lepus californicus	Black-tailed jackrabbit	G5/S5	---	---

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Sylvilagus audubonii	Desert cottontail	G5/S5	---	---
Raccoon and Ringtail				
Procyonidae				
Nasua narica	White-nosed coati	G5/S4	---	---
MAMMALS (continued)				
Procyon lotor	Common raccoon	G5/S4	---	---
Rats and Mice				
Muridae				
Mus musculus	House mouse	G5/SNA	---	---
Neotoma albigula	White-throated woodrat	G5/S5	---	---
Neotoma mexicana	Mexican woodrat	G5/S5	---	---
Onychomys leucogaster	Northern grasshopper mouse	G5/S5	---	---
Onychomys torridus	Southern grasshopper mouse	G5/S5	---	---
Peromyscus leucopus	White-footed mouse	G5/S5	---	---
Peromyscus maniculatus	Deer mouse	G5/S5	---	---
Reithrodontomys fulvescens	Fulvous harvest mouse	G5/S4	---	---
Reithrodontomys megalotis	Western harvest mouse	G5/S5	---	---
Sigmodon arizonae	Arizona cotton rat	G5/S4	---	---
Sigmodon hispidus	Hispid cotton rat	G5/S5	---	---
Sigmodon ochrognathus	Yellow-nosed cotton rat	G4G5/S3S4	SC	---
Shrews				
Soricidae				
Notiosorex crawfordi	Desert shrew	G5/S4S5	---	---
Squirrels				
Sciuridae				
Ammospermophilus harrisii	Yuma antelope squirrel	G5/S5	---	---
Spermophilus spilosma	Spotted ground squirrel	G5/S4	---	---
Spermophilus variegatus	Rock squirrel	G5/S5	---	---
REPTILES				
Box Turtles				
Emydidae				
Terrapene ornata	Desert box turtle	G5/S3S4	---	---
Mud Turtles				
Kinosternidae				
Kinosternon sonoriense	Sonoran mud turtle	G4/S4	---	---
Alligator Lizards				
Anguidae				

Group / Family / Scientific Name	Common Name	Global and State Rank	State Status	Federal Status
Elgaria kingii	Madrean alligator lizard	G5/S5	---	---
Beaded Lizards				
Helodermatidae				
Heloderma suspectum	Gila monster	G4/S4	---	---
REPTILES (continued)				
Collared and Leopard Lizards				
Crotaphytidae				
Crotaphytus collaris	Collared lizard	G5/S5	---	---
Gambelia wislizenii	Long-nosed leopard lizard	G5/S5	---	---
Iguanid Lizards				
Phrynosomatidae				
Holbrookia maculata	Lesser earless lizard	G5/S5	---	---
Phrynosoma cornutum	Texas horned lizard	G4G5/S3S4	----	---
Phrynosoma solare	Regal horned lizard	G5/S5	---	---
Sceloporus clarkii	Clark's spiny lizard	G5/S5	---	---
Sceloporus undulatus	Eastern fence lizard	G5/SNR	---	---
Urosaurus ornatus	Ornate tree lizard	G5/S5	---	---
Whiptail Lizards				
Teiidae				
Cnemidophorus uniparens	Desert grassland whiptail	G5/S5	---	---
Colubrid Snakes				
Colubridae				
Arizona elegans	Glossy snake	G5/S5	---	---
Diadophis punctatus	Ring-necked snake	G5/S4	---	---
Hypsiglena torquata	Nightsnake	G5/S5	---	---
Lampropeltis getula	Common kingsnake	G5/S5	---	---
Masticophis bilineatus	Sonoran whipsnake	G5/S5	---	---
Masticophis flagellum	Coachwhip	G5/S5	---	---
Pituophis catenifer	Gopher snake	G5/S5	---	---
Rhinocheilus lecontei	Long-nosed snake	G5/S5	---	---
Salvadora hexalepis	Western patch-nosed snake	G5/S5	---	---
Sonora semiannulata	Ground snake	G5/S5	---	---
Tantilla hobartsmithii	Southwestern black-headed snake	G5/S5	---	---
Thamnophis eques	Mexican garter snake	G5/S2S3	---	---
Thamnophis marcianus	Checkered garter snake	G5/S5	---	---
Coral Snakes				
Elapidae				
Micruroides euryxanthus	Sonoran coral snake	G5/S5	---	---
Rattlesnakes				

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Viperidae				
Crotalus atrox	Western diamondbacked rattlesnake	G5/S5	---	---
Crotalus scutulatus	Mojave rattlesnake	G5/S5	---	---
AMPHIBIANS				
Spadefoot Toads				
Pelobatidae				
Scaphiopus couchii	Couch's spadefoot	G5/S5	---	---
Spea multiplicata	Mexican spadefoot	G5/S5	---	---
Toads				
Bufonidae				
Bufo alvarius	Colorado River toad	G5/S5	---	---
Bufo cognatus	Great Plains toad	G5/S5	---	---
Bufo debilis	Green toad	G5/S3	---	---
Bufo punctatus	Red-spotted toad	G5/S5	---	---
Bufo woodhousii	Woodhouse's toad	G5/S5	---	---
True Frogs				
Ranidae				
Rana catesbeiana	Bullfrog	G5/SNA	---	---
Rana chiricahuensis	Chiricahua leopard frog	G3/S3	LT	WSC
Rana yavapaiensis	Lowland leopard frog	G4/S4	SC	WSC
FISH				
Catfish				
Ictaluridae				
Ictalurus pricei	Yaqui catfish	G2/S1	LT	WSC
Minnows				
Cyprinidae				
Campostoma ornatum	Mexican stoneroller	G3/S1	SC	WSC
Cyprinella formosa	Beautiful shiner	G2/S1	LT	WSC
Gila purpurea	Yaqui chub	G1/S1	LE	WSC
Gila robusta	Roundtail chub	G3/S2	---	---
Rhinichthys chrysogaster	Longfin dace	G4/S3S4	SC	---
Suckers				
Catostomidae				
Catastomus bernardini	Yaqui sucker	G4/SX	---	---
Topminnows				
Poeciliidae				
Poeciliopsis occidentalis sonoriensis	Yaqui topminnow	G3T3/S1	LE	WSC

Source: USFWS 2003

(b) (7)(E) Watchable Wildlife List. Global and State Rank from NatureServe 2008.

Federal and State Status from AGFD 2007.